

News from a Warming Planet

Challenges and Opportunities for the State of Wisconsin

Prof. Jon Foley, Director

Center for Sustainability and the Global Environment (SAGE)
University of Wisconsin



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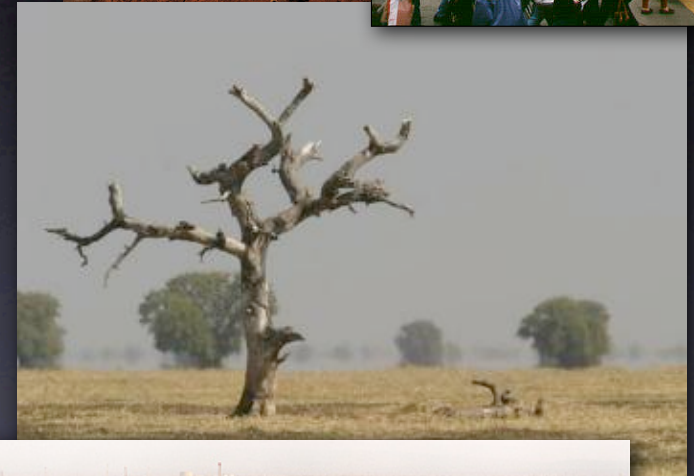
Recent History...



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Acceleration of History...

- between 1950 and 2000...
 - *population more than doubled*
 - *economy grew seven-fold*
- increasing agriculture
 - *food consumption almost tripled*
 - *water use roughly tripled*
- and energy use
 - *fossil fuel use increased four-fold*

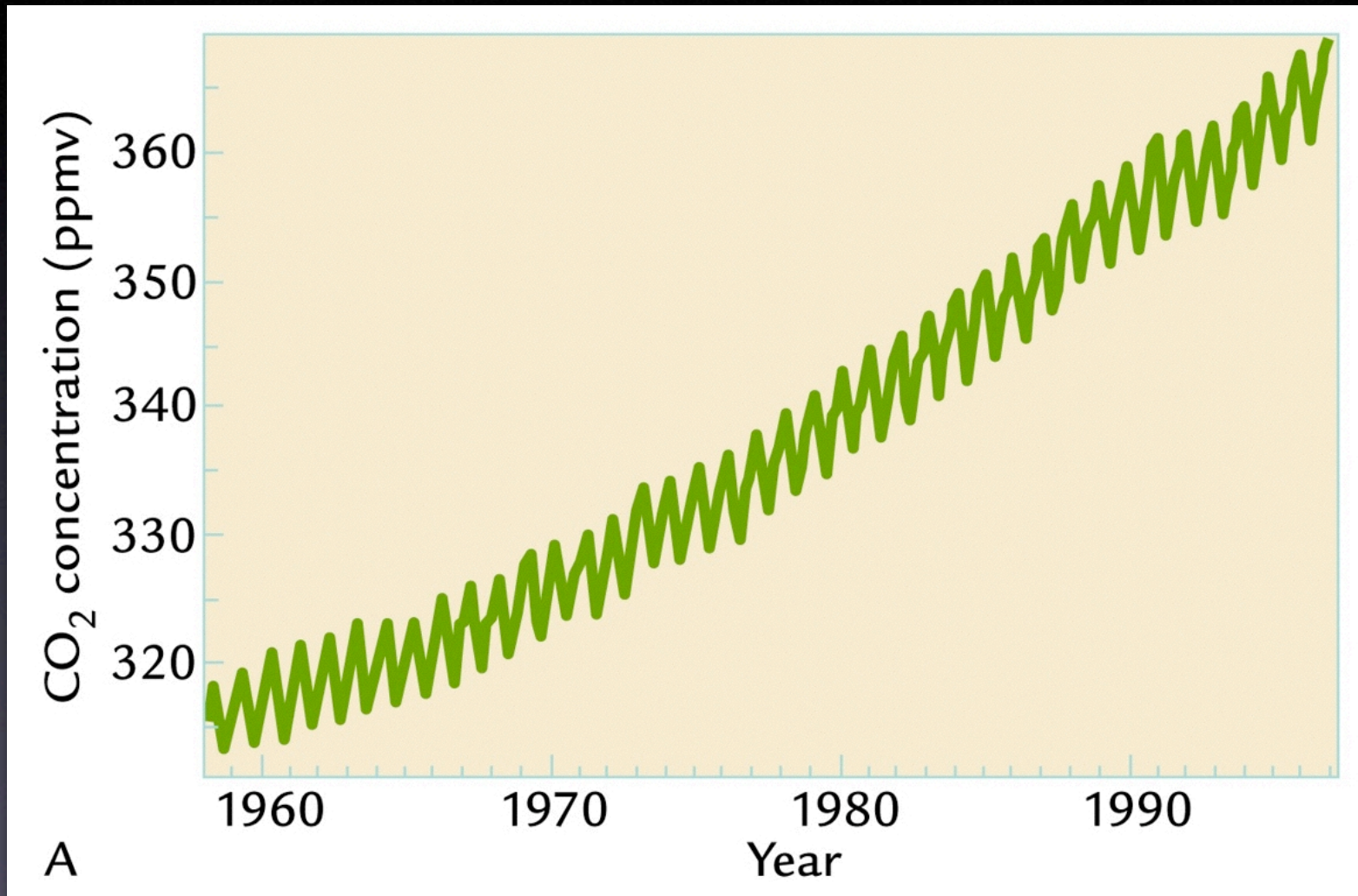


The Planet has Noticed...

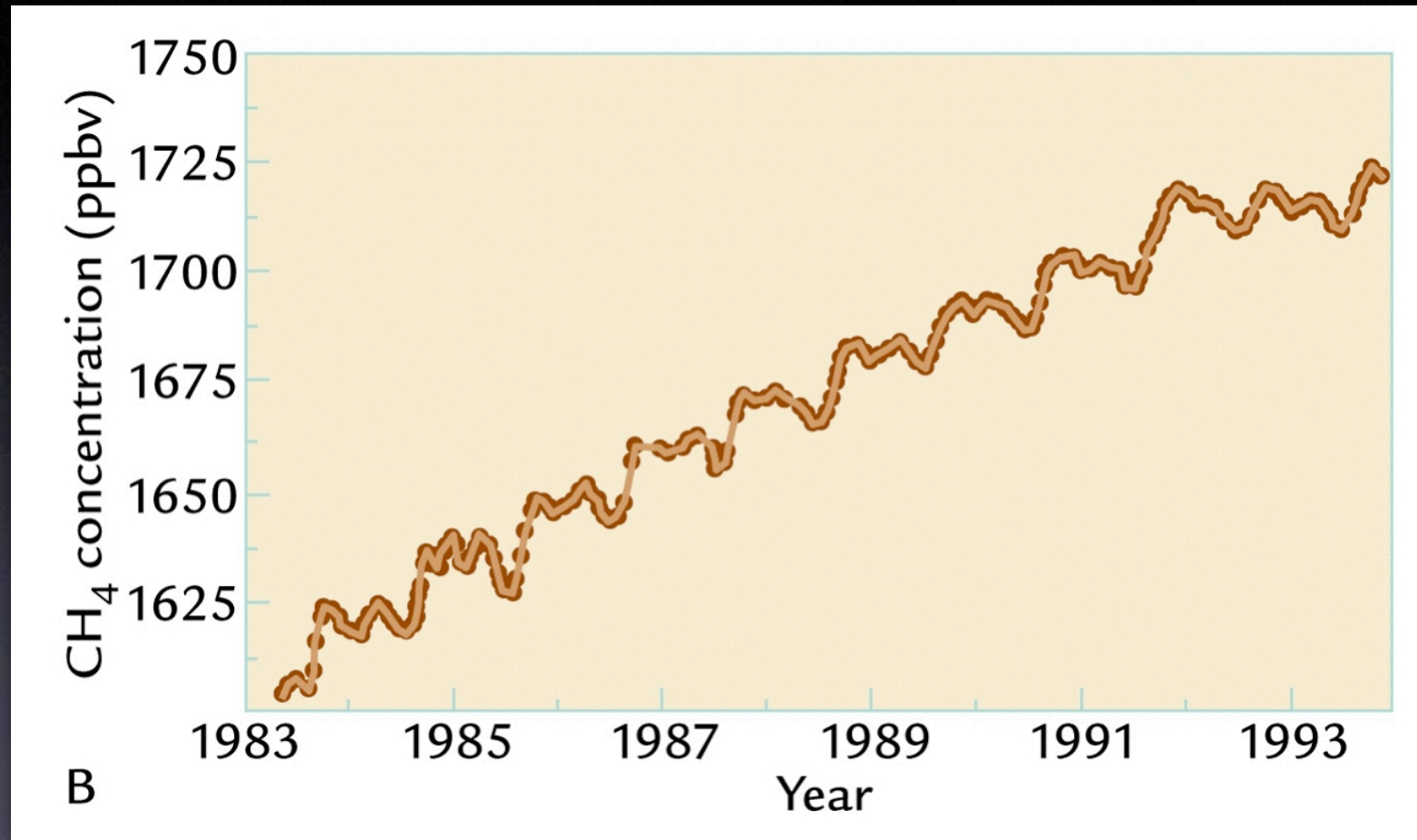


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Increasing Carbon Dioxide



Increasing Methane



A Warming Planet



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Image: Apple

You've Heard This Before...

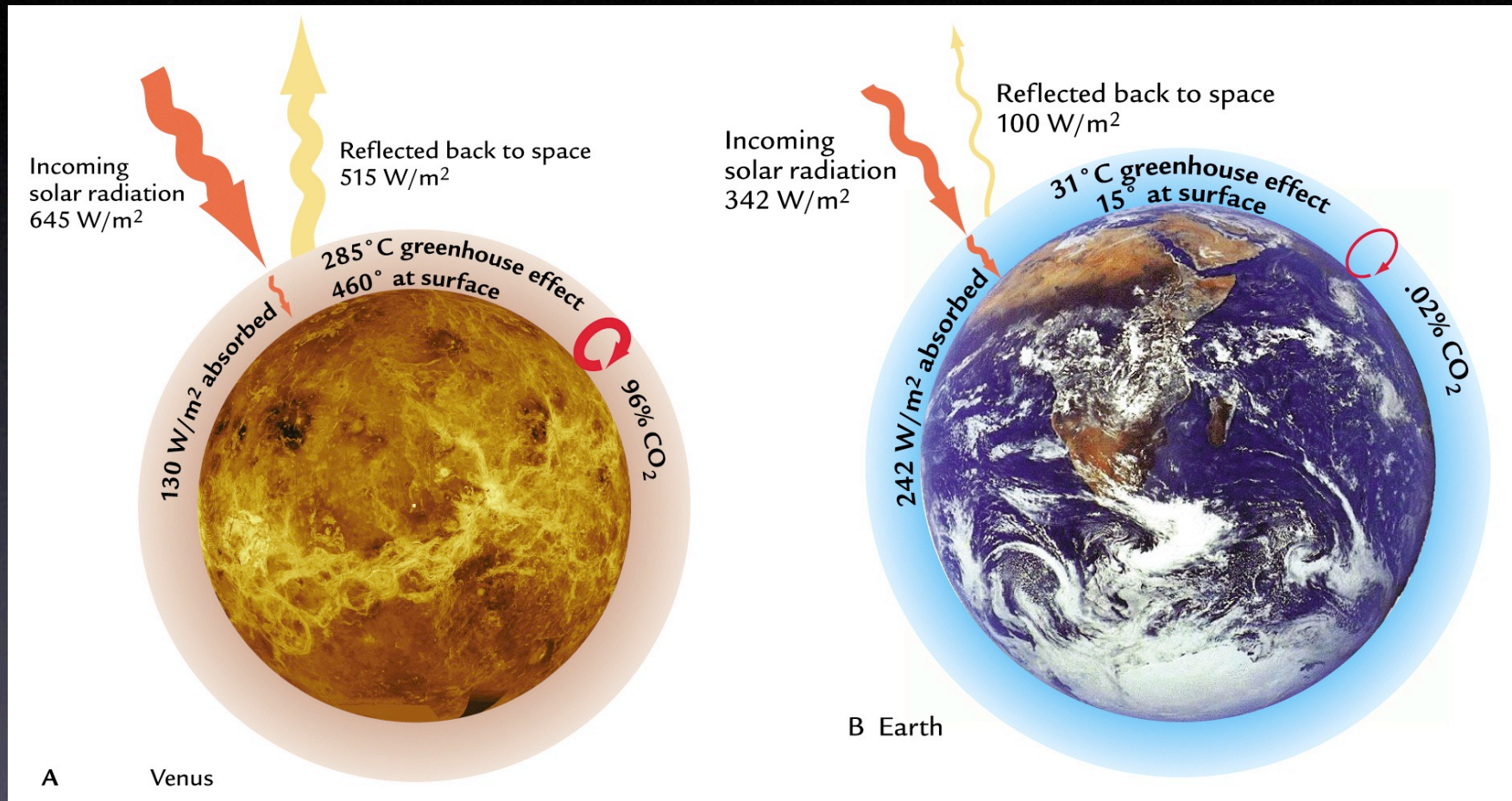


It's Just Physics 101



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A Tale of Two Planets



This is *Not* a New Idea



Svante Arrhenius



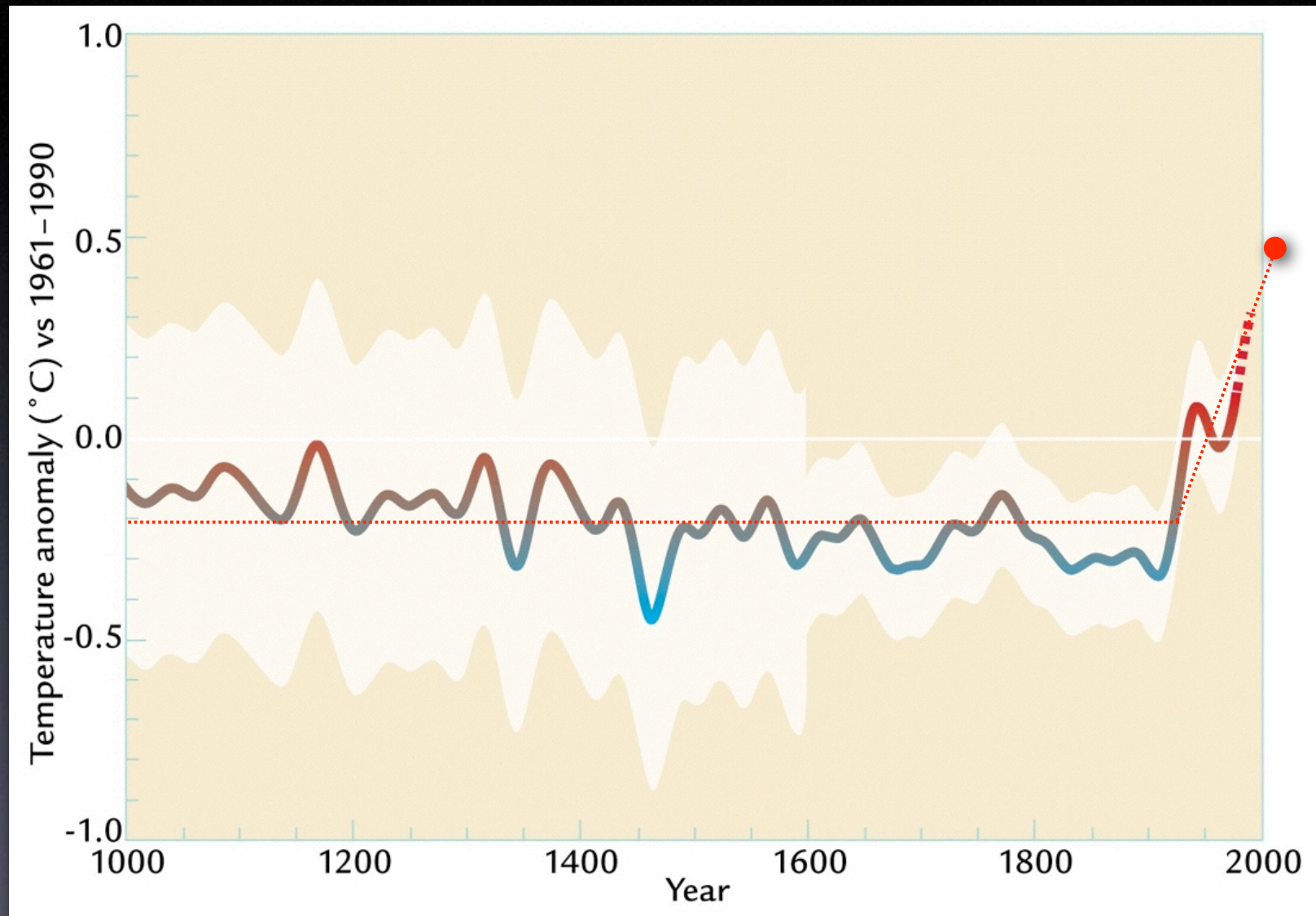
T.C. Chamberlain



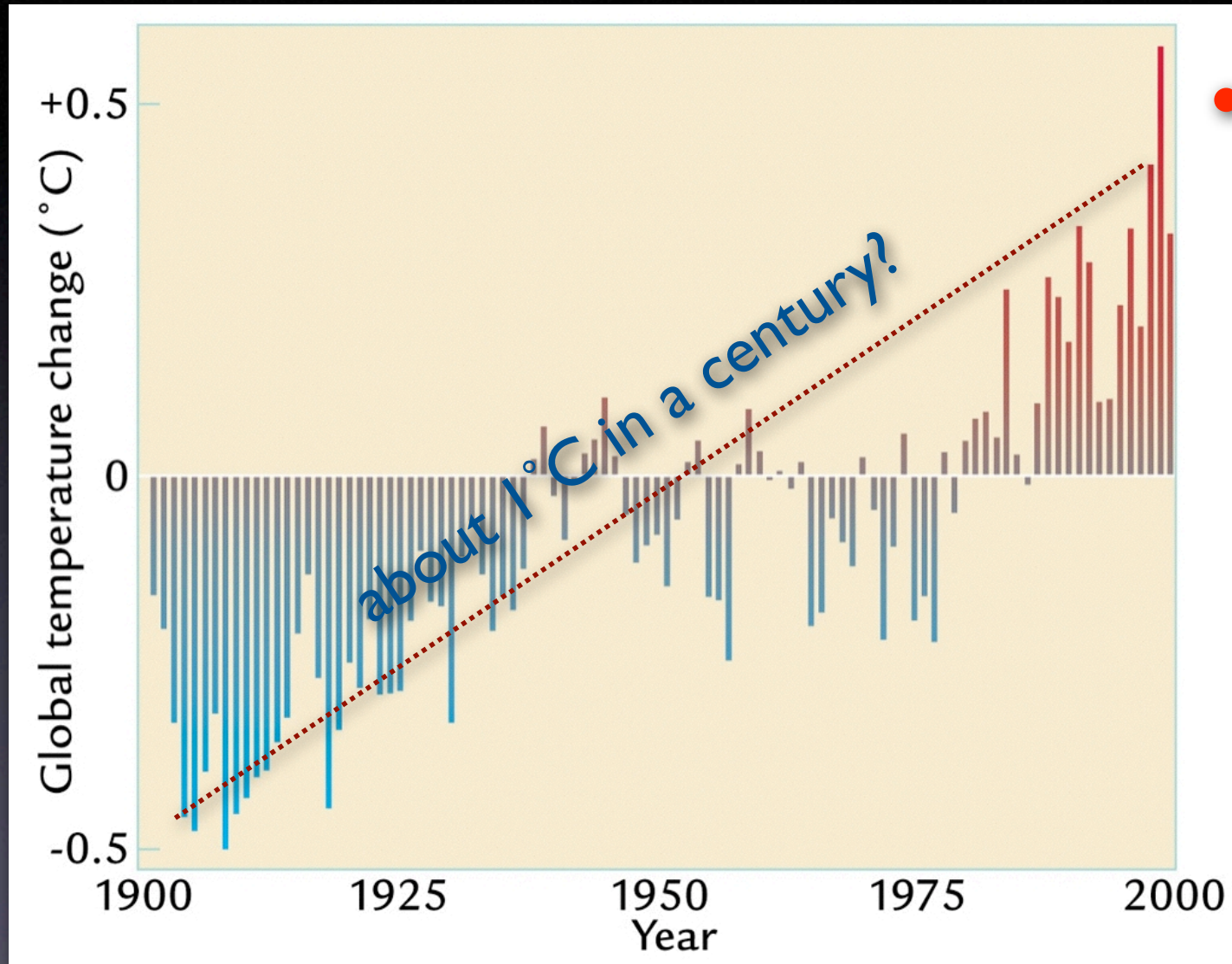
The Data



2nd Millennium Climate Record



20th Century Warming



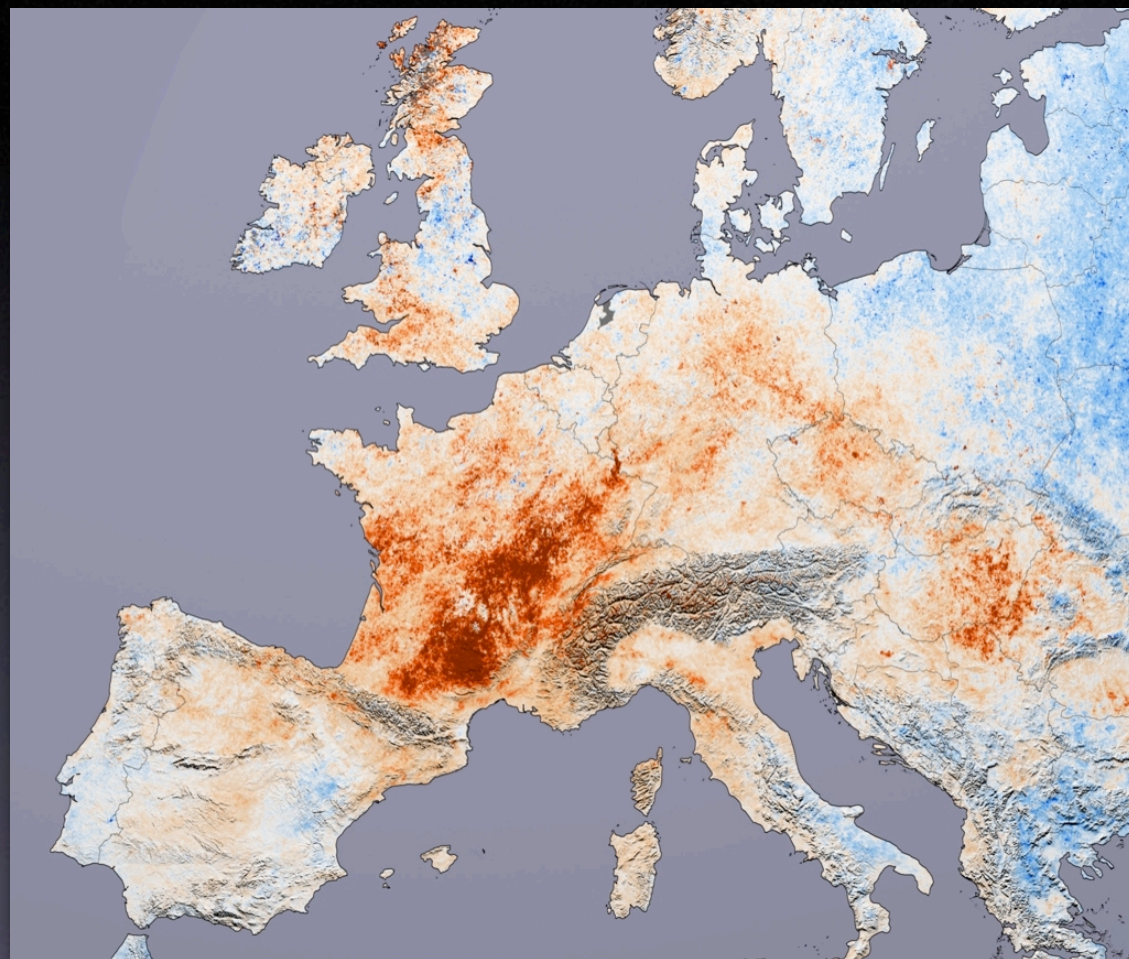
Hottest Years on Record



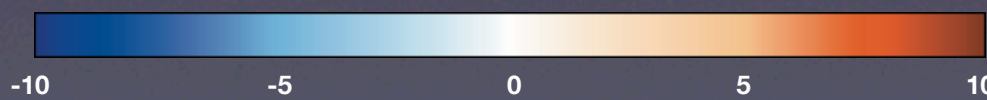
Regional Warming

- Europe 2003

Country	Death Toll
France	15,000
Netherlands	1,400
Portugal	1,300
Italy	20,000
UK	900
Spain	100



Temperature anomaly (C°)



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Image: Gore

Regional Warming

- Eastern U.S. 2005

June 23, 2005 La Crosse, WI hit 98° F

July 25, 2005, New Orleans hit 98° F

July 26, 2005, Florence, SC hit 101° F

July 26, 2005, Raleigh-Durham, NC hit 101° F

July 27, 2005, Newark, NJ hit 101° F



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Image: National Weather Service, Gore

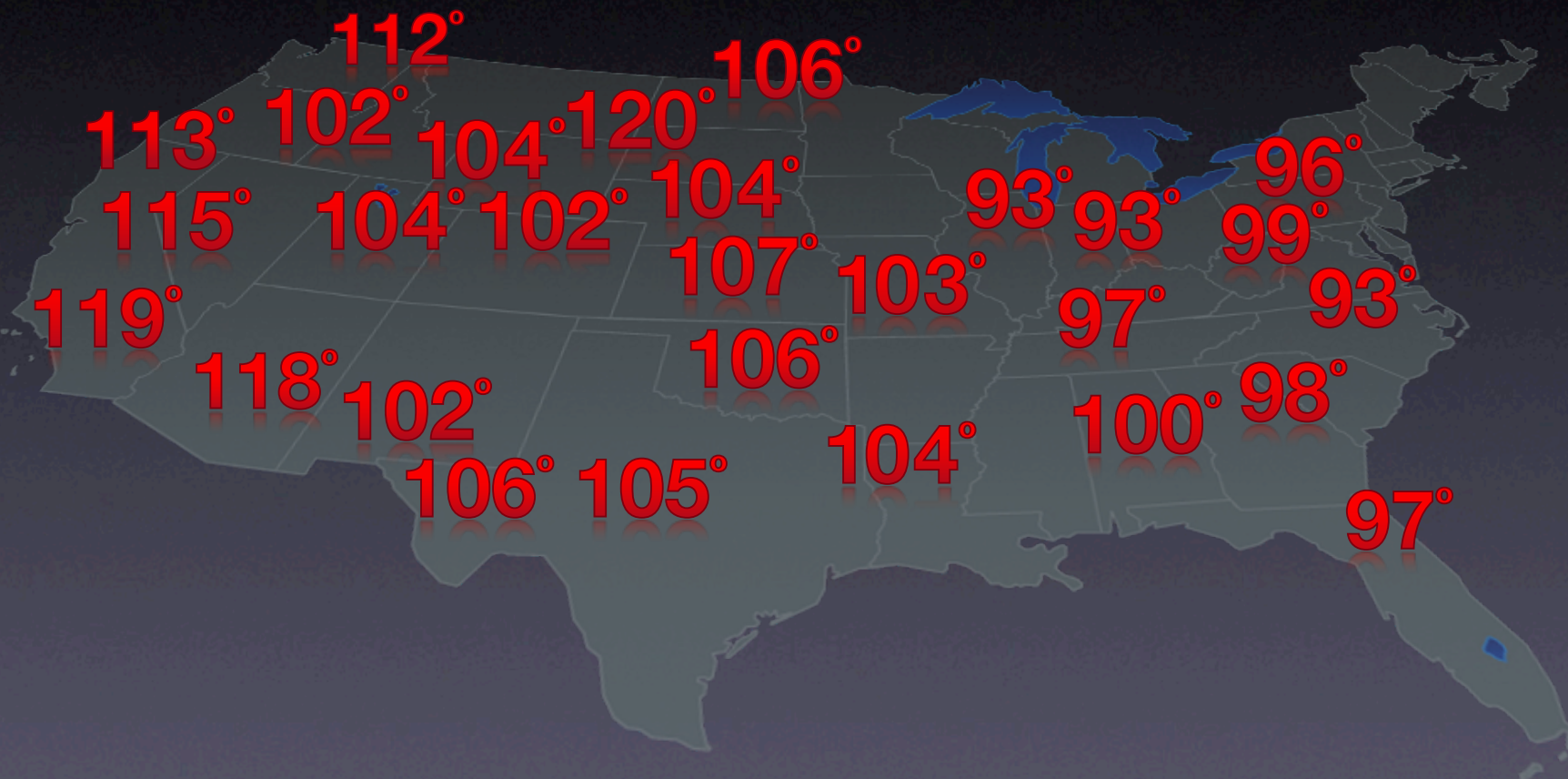
Regional Warming

- Europe, Summer 2006



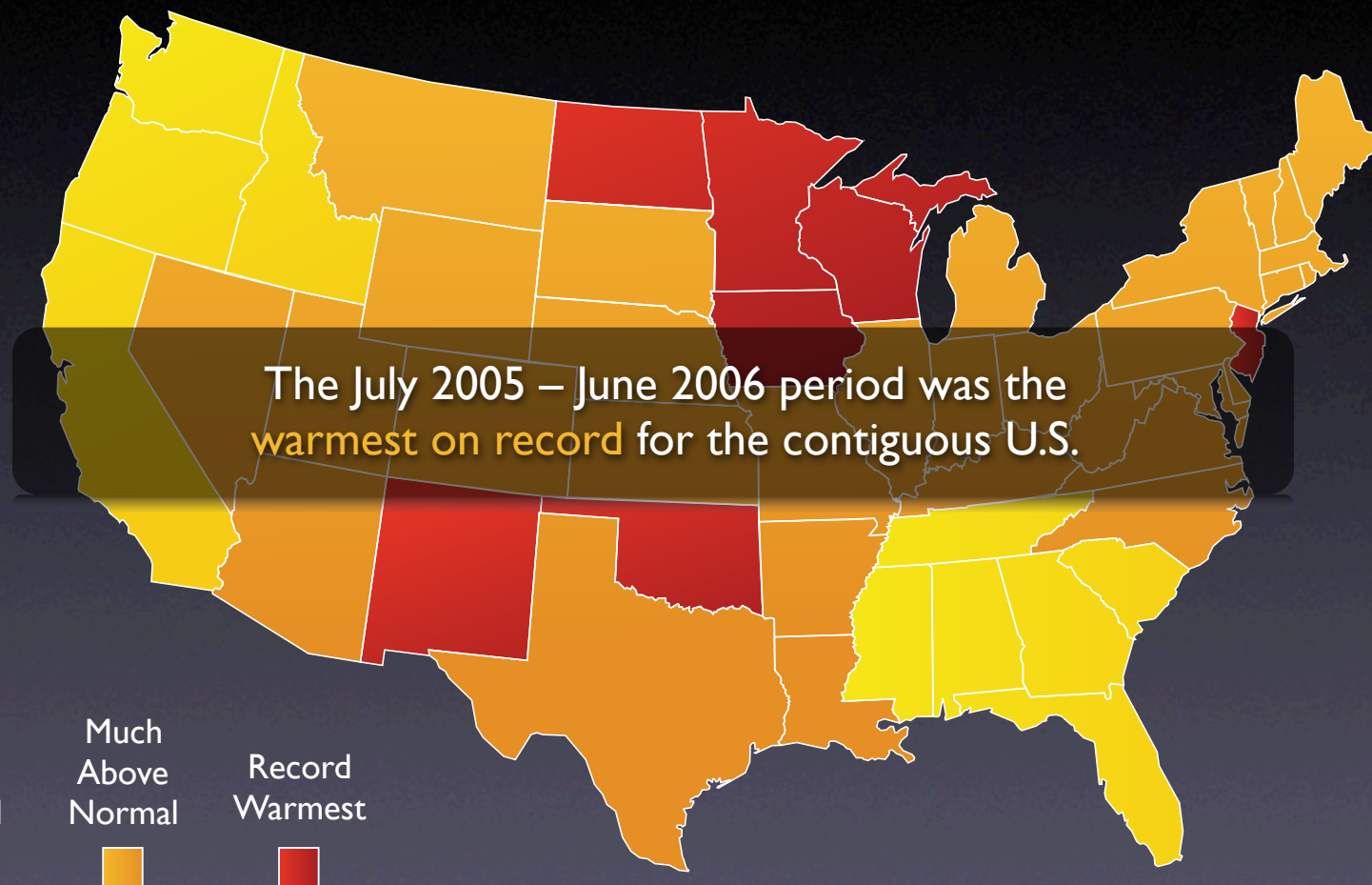
Regional Warming

- U.S., July 2006



Regional Warming

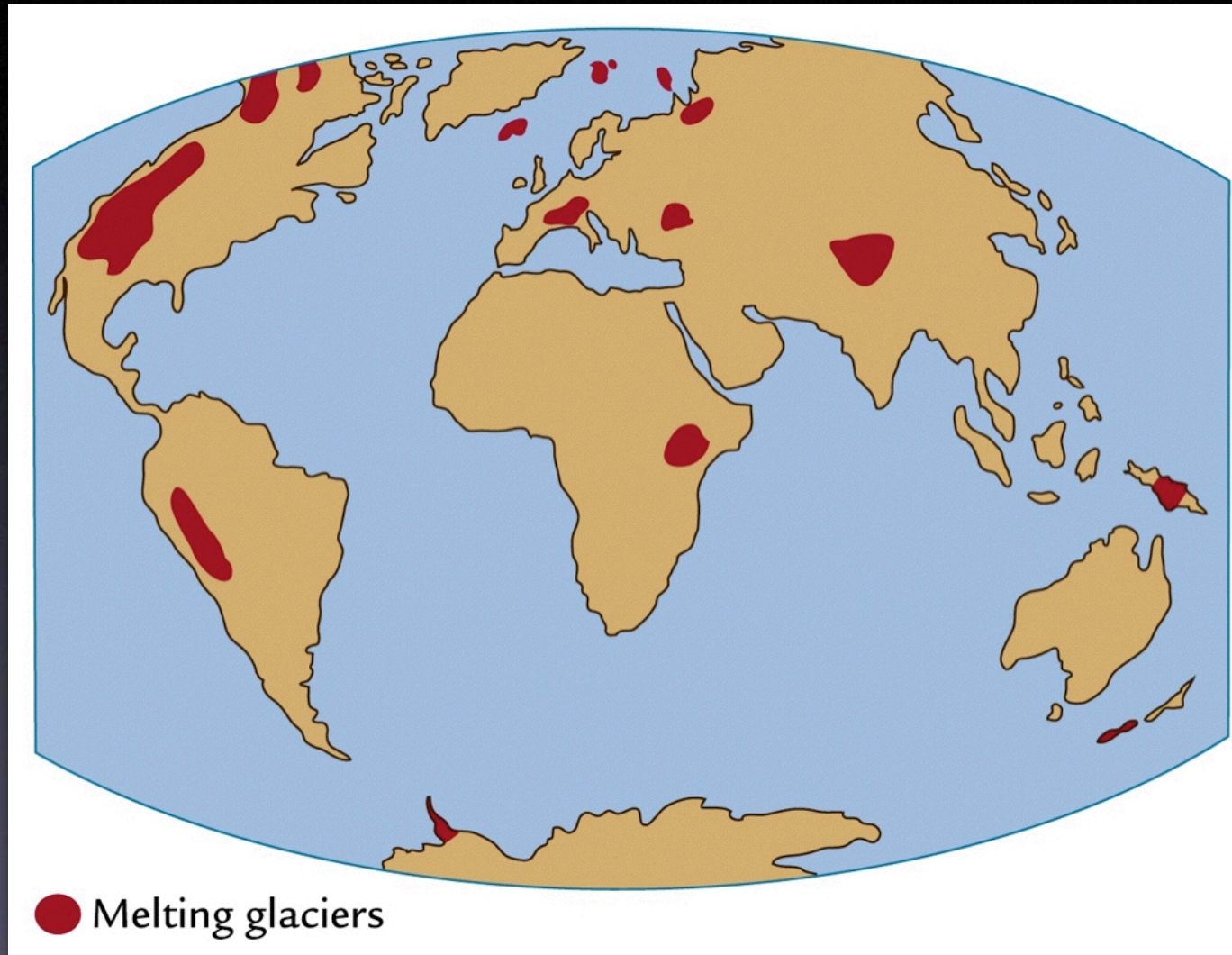
- U.S. 2005-06



Other Evidence



Other Evidence: Glaciers?



1941



Muir Glacier, Alaska

2004



Online glacier photograph database.
Boulder, CO: National Snow and Ice
Data Center/World Data Center for
Glaciology. Digital media.



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1909



Holgate Glacier, Alaska

2004

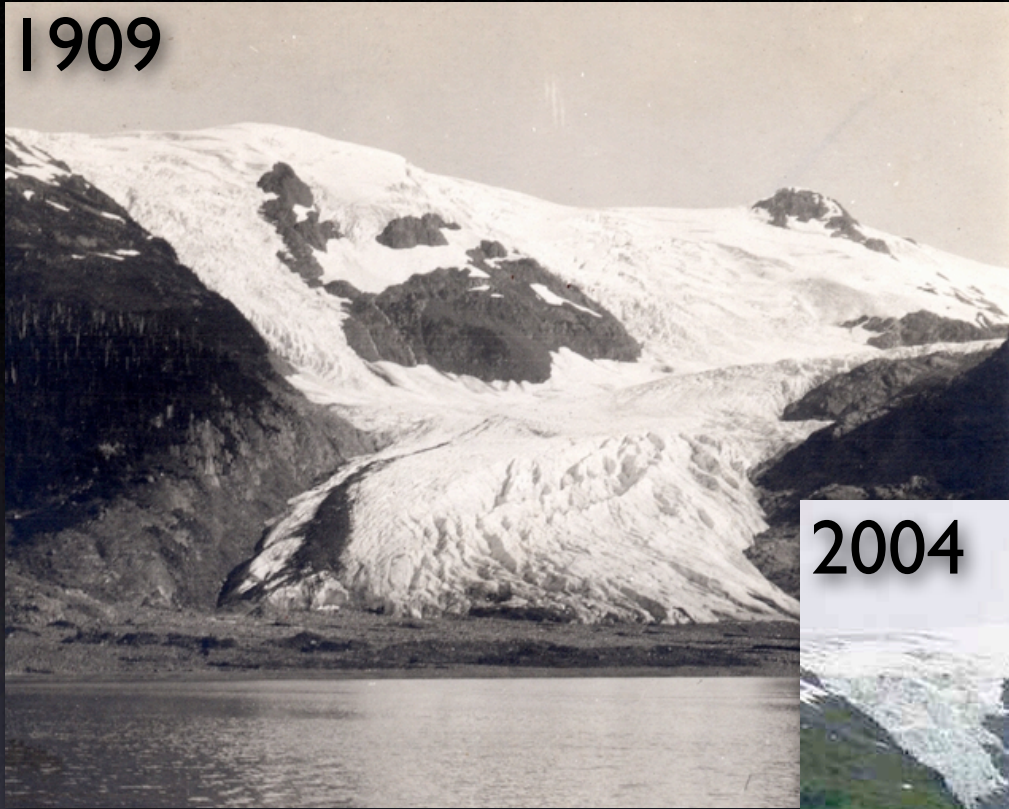


Online glacier photograph database.
Boulder, CO: National Snow and Ice
Data Center/World Data Center for
Glaciology. Digital media.



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1909



Toboggan Glacier, Alaska

2004

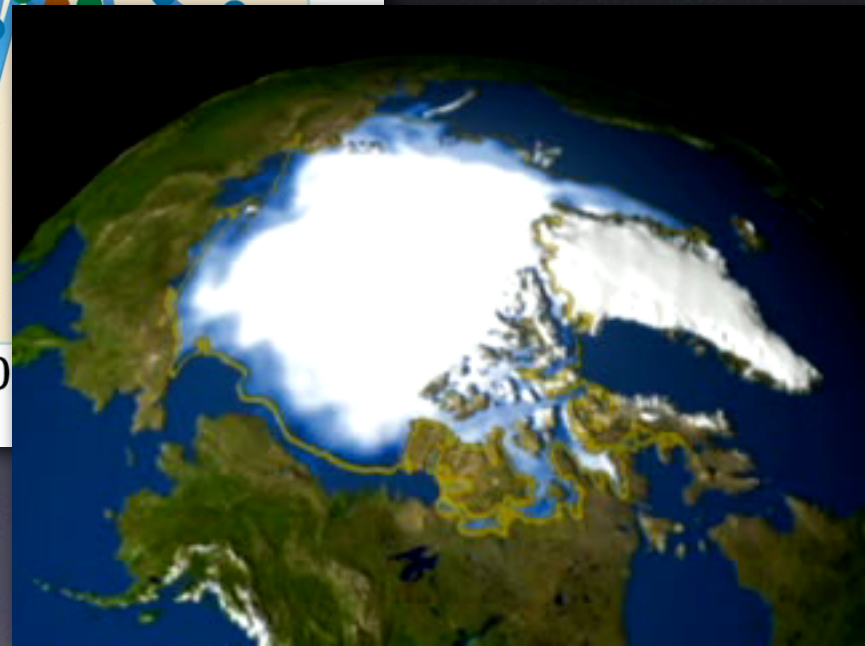
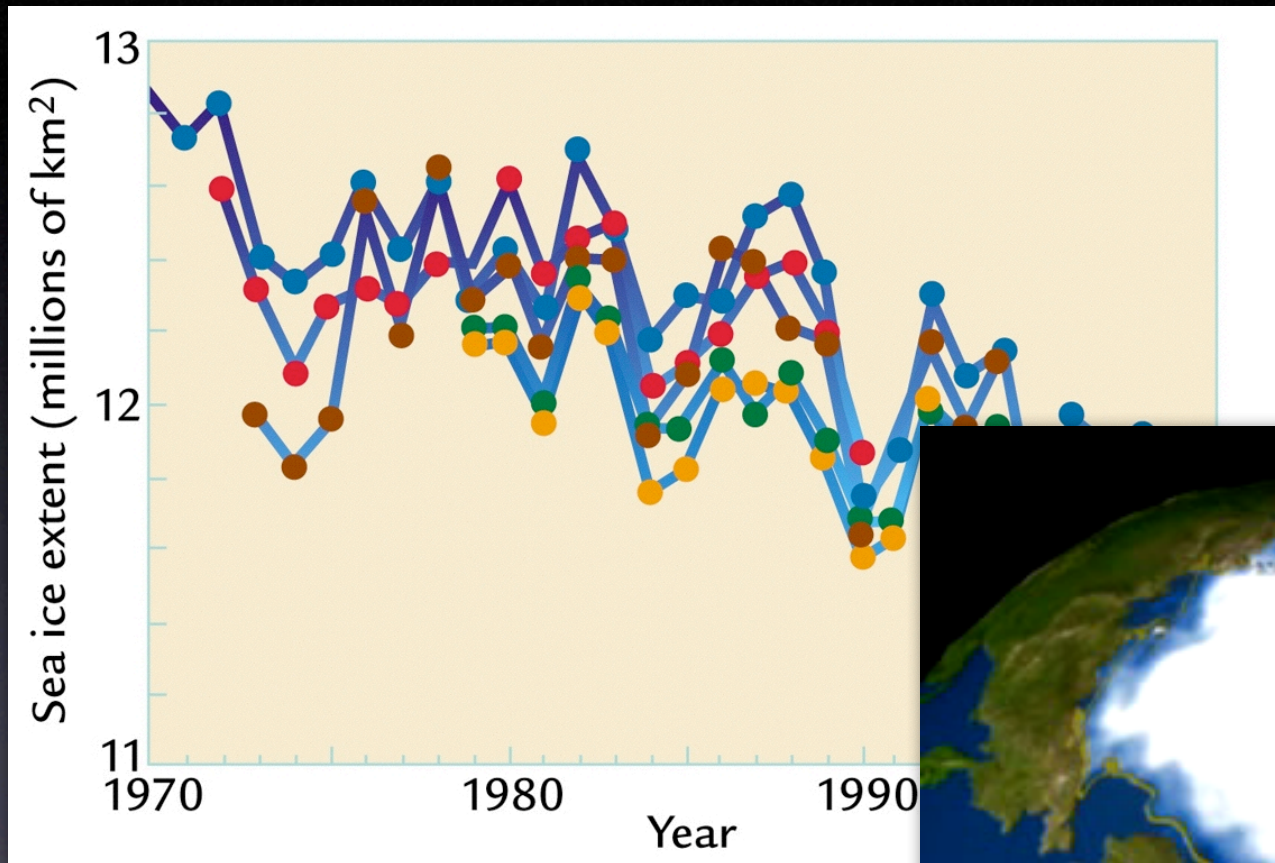


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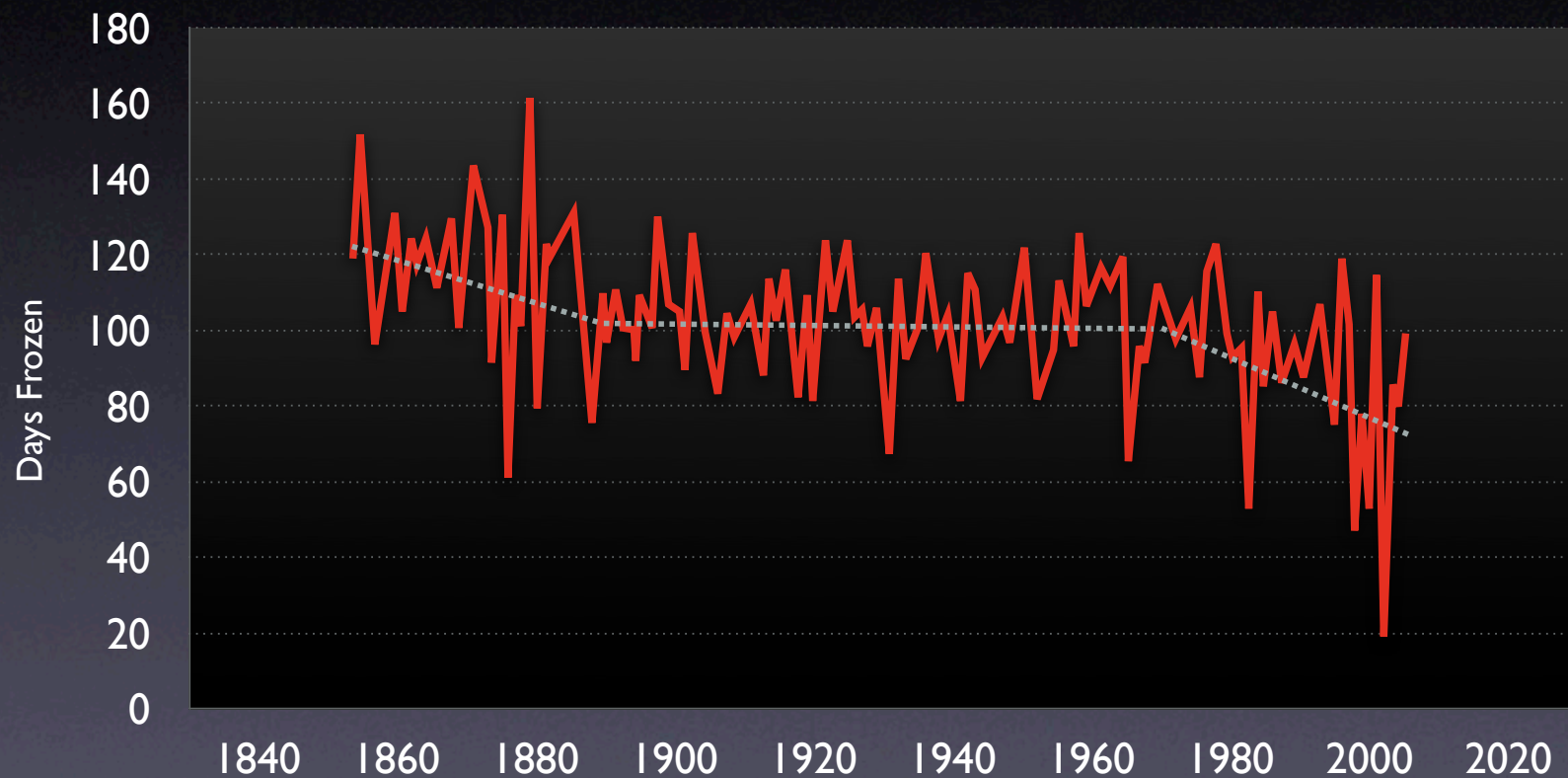
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Other Evidence: Sea Ice

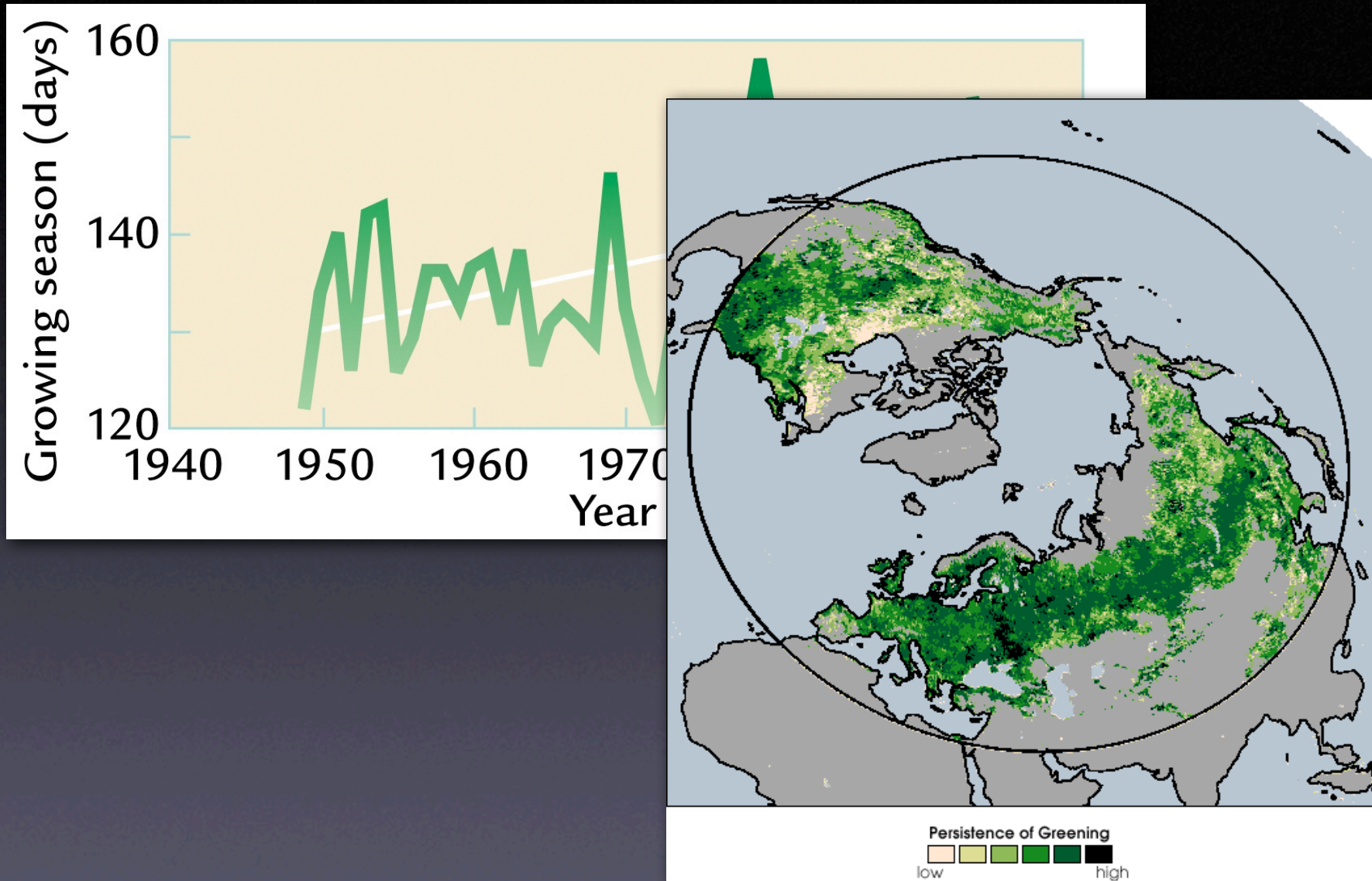


Other Evidence: Lake-Ice

Lake Mendota, Wisconsin



Other Evidence: Seasons



But Myths Persist



“Well, It’s Just a Theory”

- actually, this is right
- but a theory is not a “guess”
 - *that’s a hypothesis*
- a theory fits all of the available data
- other “theories”
 - *gravity*
 - *earth is round*
 - *earth goes around the sun*



“The Scientists Aren’t Sure”

- absolutely not true
- recent analysis of scientific data (Oreskes, 2004)
 - 928 peer-reviewed papers: evidence for human-induced warming
 - 0 showed otherwise
- all international scientific organizations agree
 - IPCC, U.S. NAS, AMS, AGU, AAAS, etc...
- handful of professional “skeptics” -- that’s all



“It’s a Left-Wing Eco-Conspiracy!”



A Real Human Dilemma

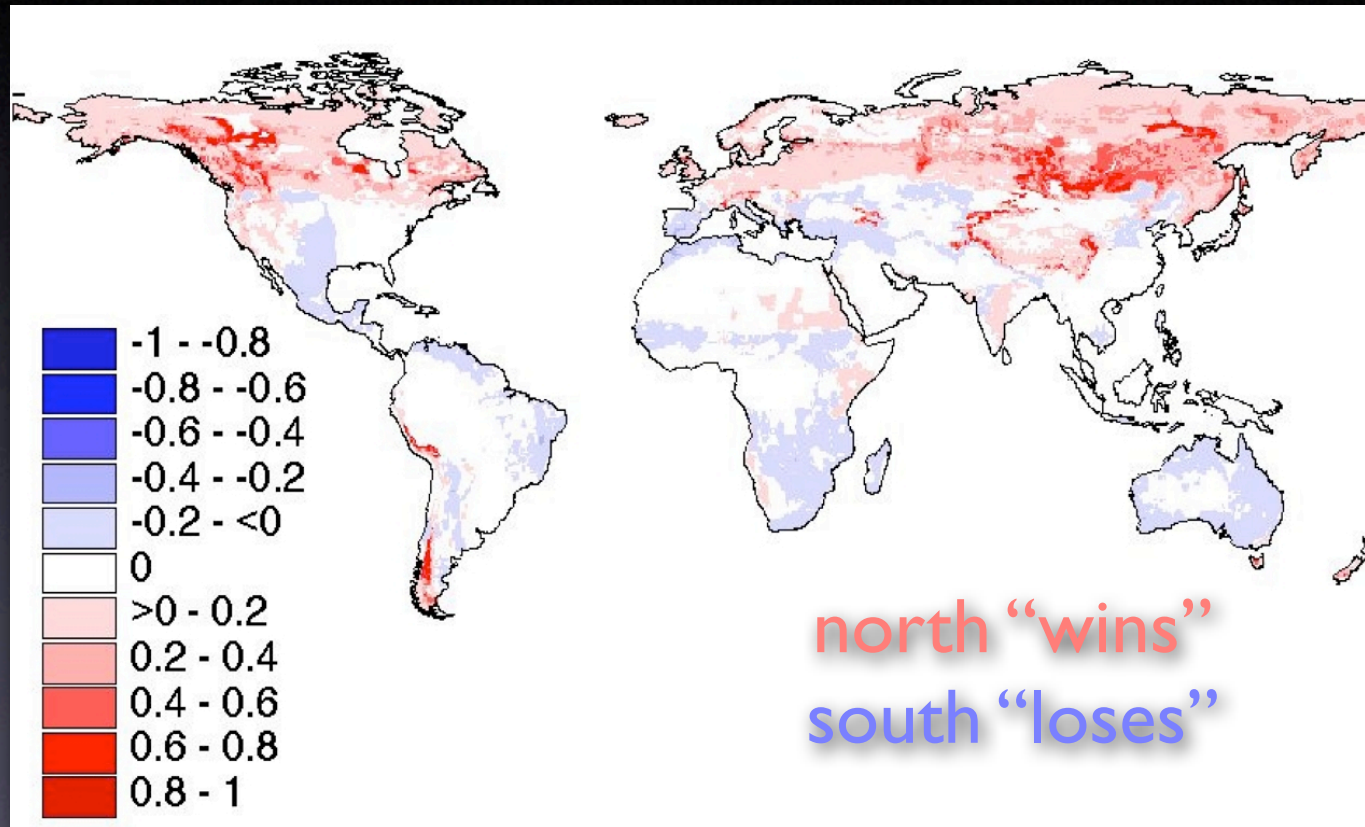


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Image: Apple

Food Security Impacts

- future changes in agricultural production?



Source: Ramankutty et al., 2002



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Health Impacts -- Today

~150,000 deaths / year....right now

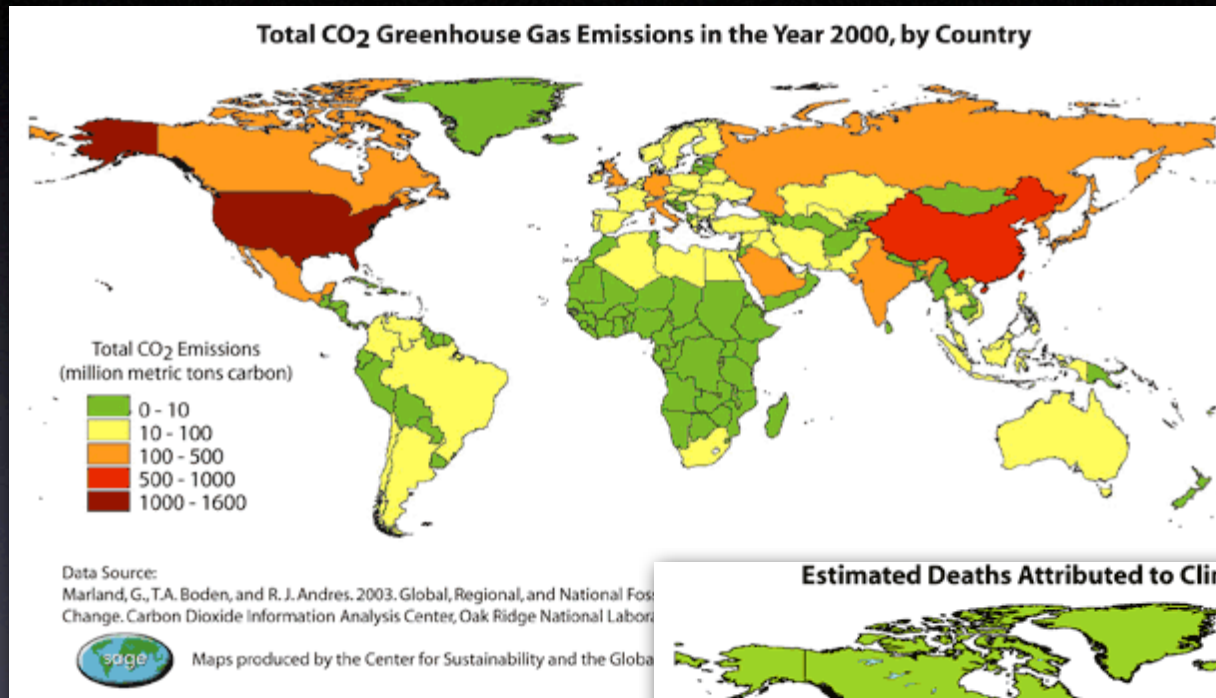
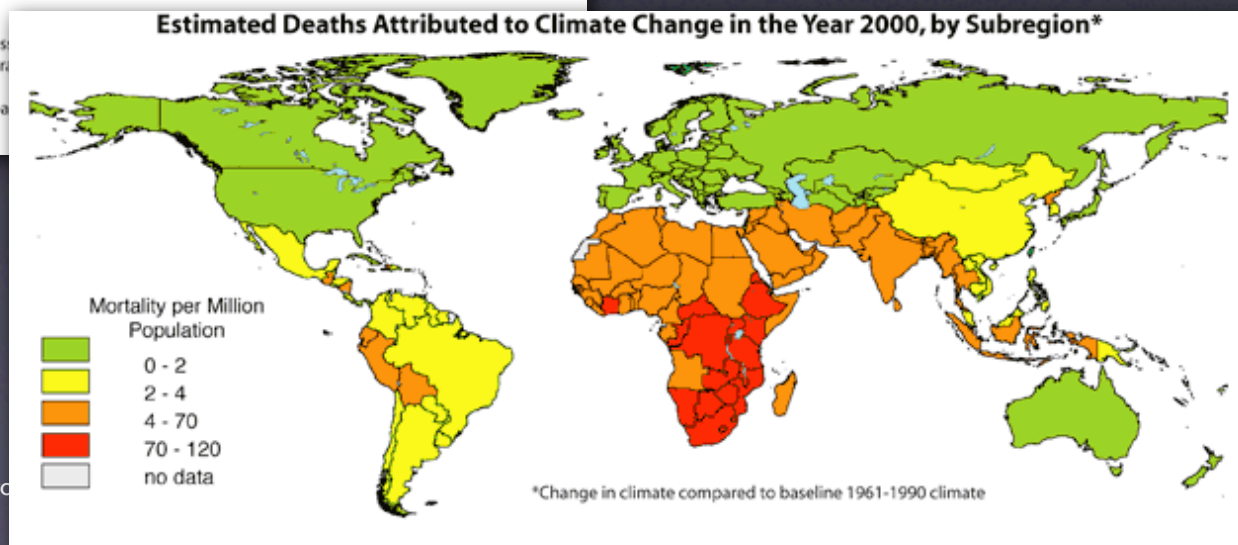


Image: Patz et al., Nature, 2005




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Those Hardest Hit

- sensitive regions
 - *Arctic, coral reefs, tropical countries, small island nations, ...*
- major irony: *these people emit little pollution!*
- security issue
 - *massive destabilization*
 - *refugees*
- moral issue
 - *equity, ethics*





Unlike Any Environmental Problem We've Faced Before

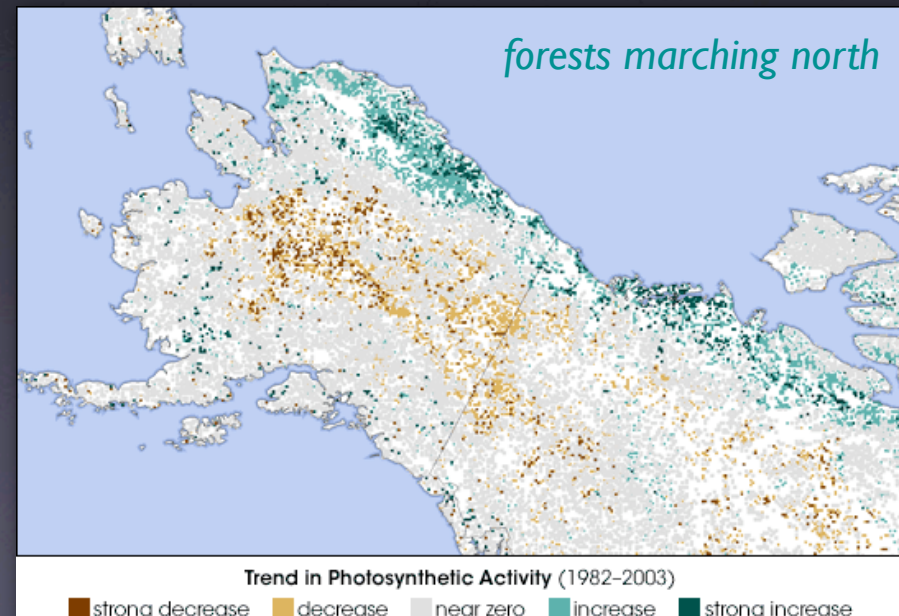


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Image: NASA

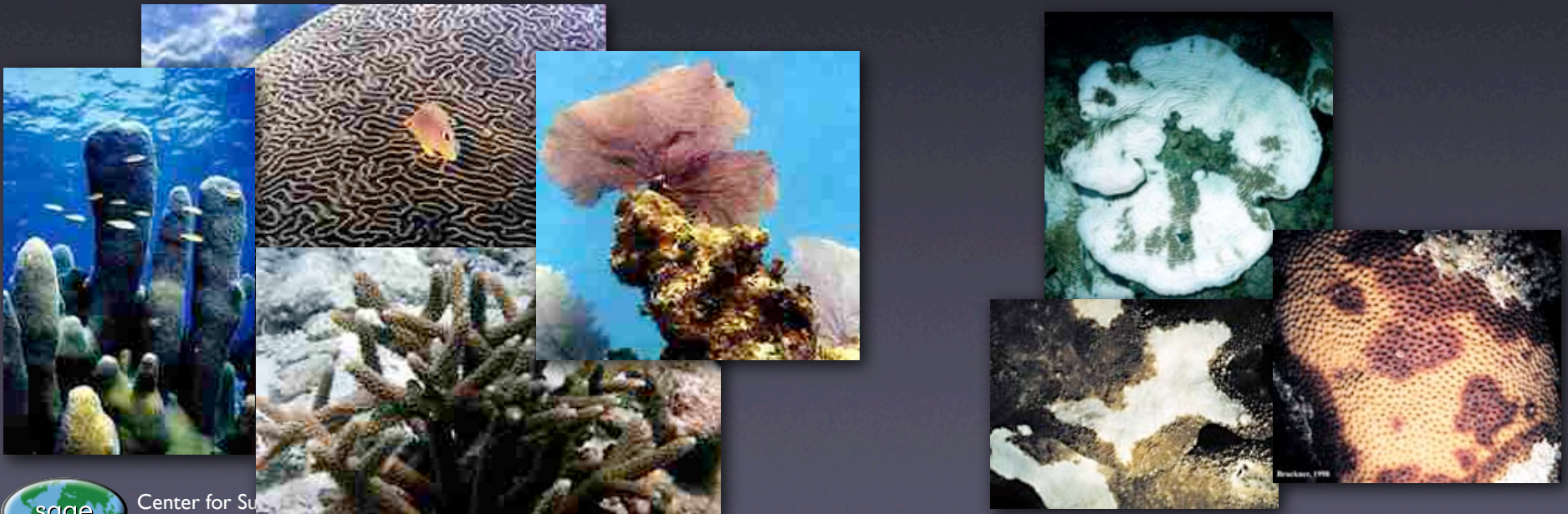
Arctic Ecosystems

- already seeing strong warming
- shrubs, forests marching north
- darker surface, more warming: *nasty feedback!*
- *Arctic systems at a tipping point?*



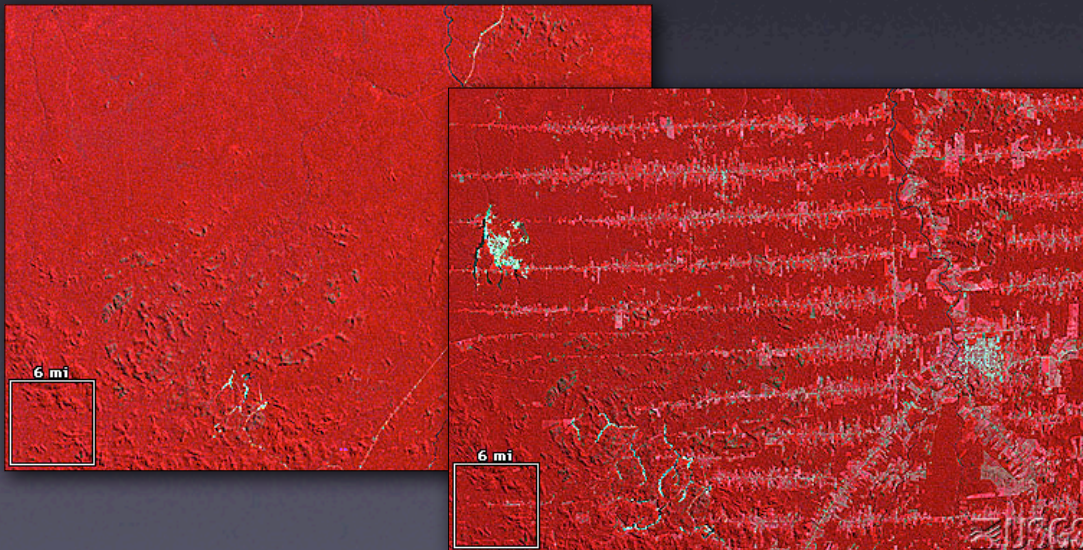
Coral Reefs

- over-harvesting fish, new diseases
- ocean warming, coral bleaching
- ocean acidification
- *lose most coral reefs by mid century?*



Tropical Forests

- deforestation
- drying forests, more fires
- wild card: global warming
- *potential for massive die off?*



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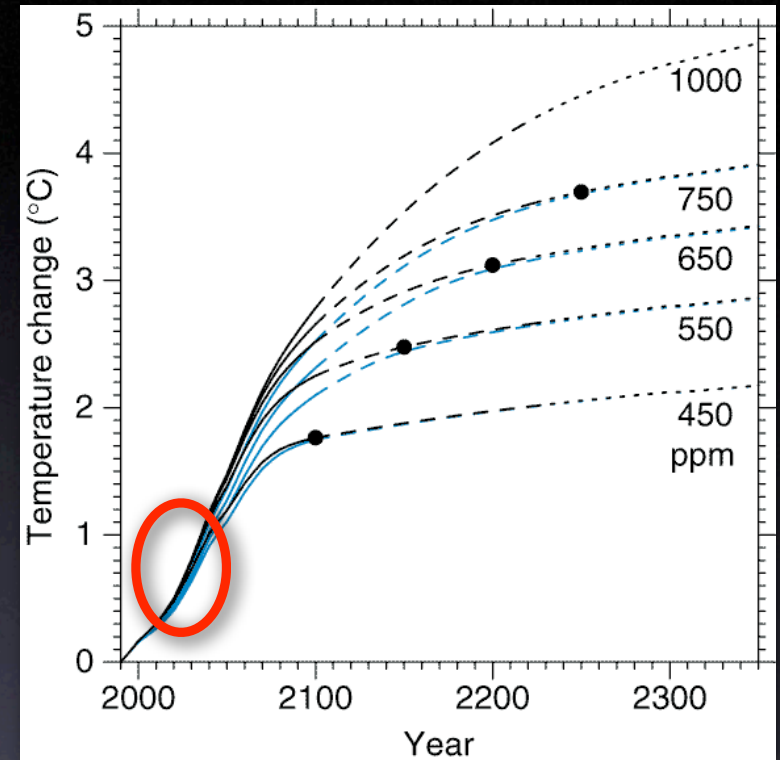
Biosphere Lost?

- threat to whole regions
 - *coral reefs, Arctic, tropical forests, ...*
- threat to whole cultures
 - *small island nations, Inuit peoples, indigenous tropical peoples, ...*
- losses will become irreversible, unless actions are taken now



Running Out of Time

- huge inertia in system
 - *CO₂ in atmosphere ~110 years*
 - *“thermal lag” ~decades*
- we can't wait and then “stop on a dime”
- narrow window to prevent catastrophic losses
 - *if we're lucky, we have a decade – maybe two*



Are We Up to the Challenge?



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Image: Apple

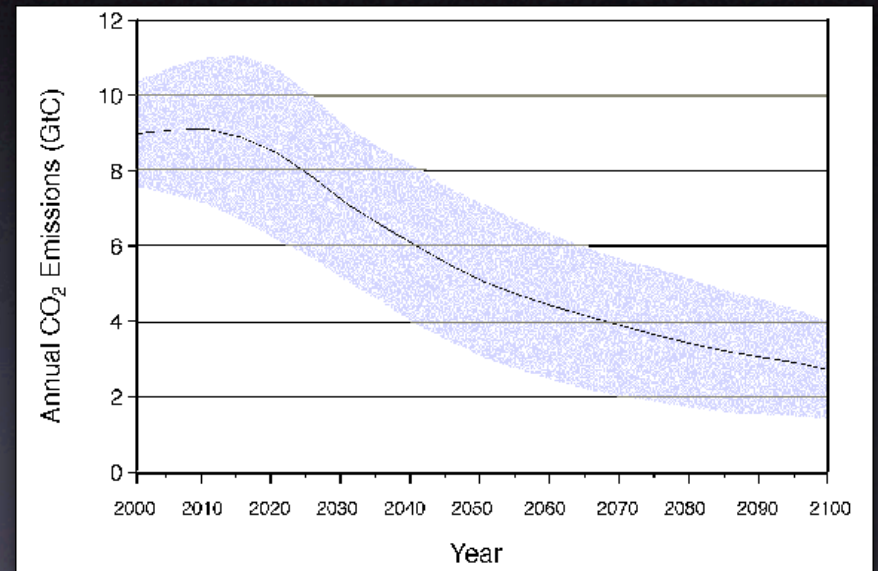
This is Going
to be *Very Hard*



Climate Stabilization is *not* a minor tweak

- “politically realistic” is not enough

- *major emissions cuts*



- stop pretending...

- *social & economic “realities” are fixed things*
 - *laws of physics are optional*

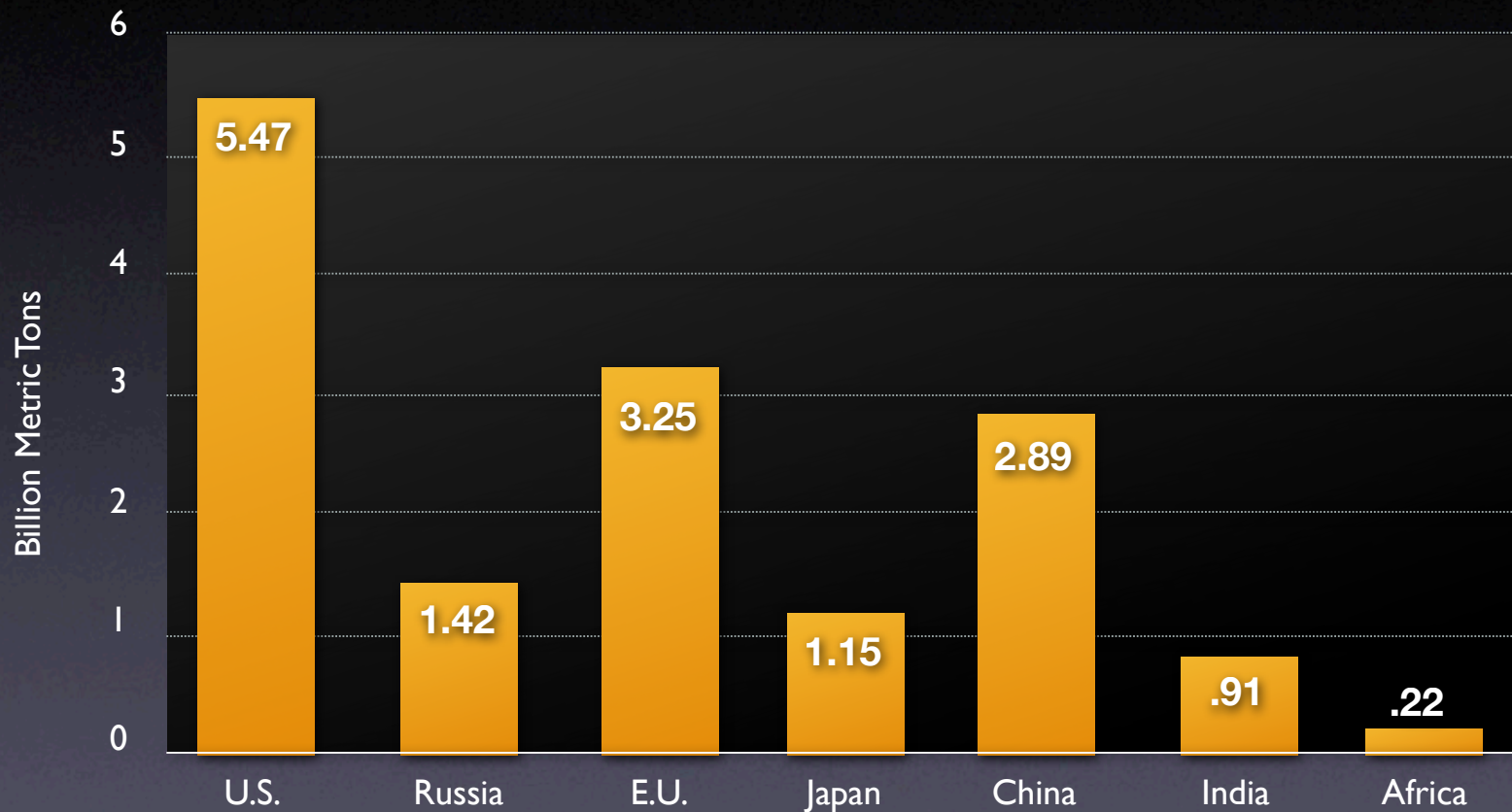


Who Needs to Act?

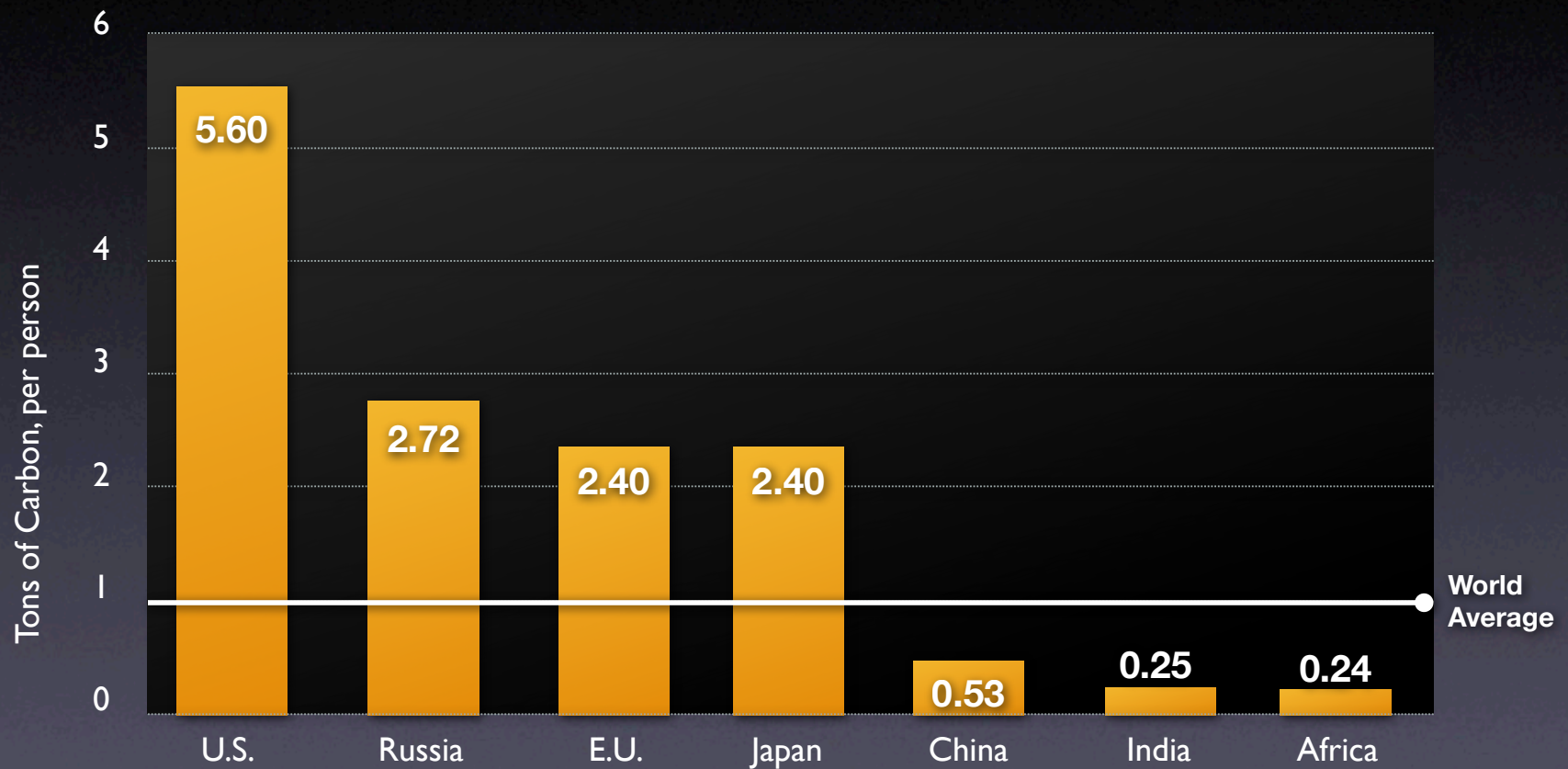


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Carbon Emissions *by Region*



Carbon Emissions *per Person*



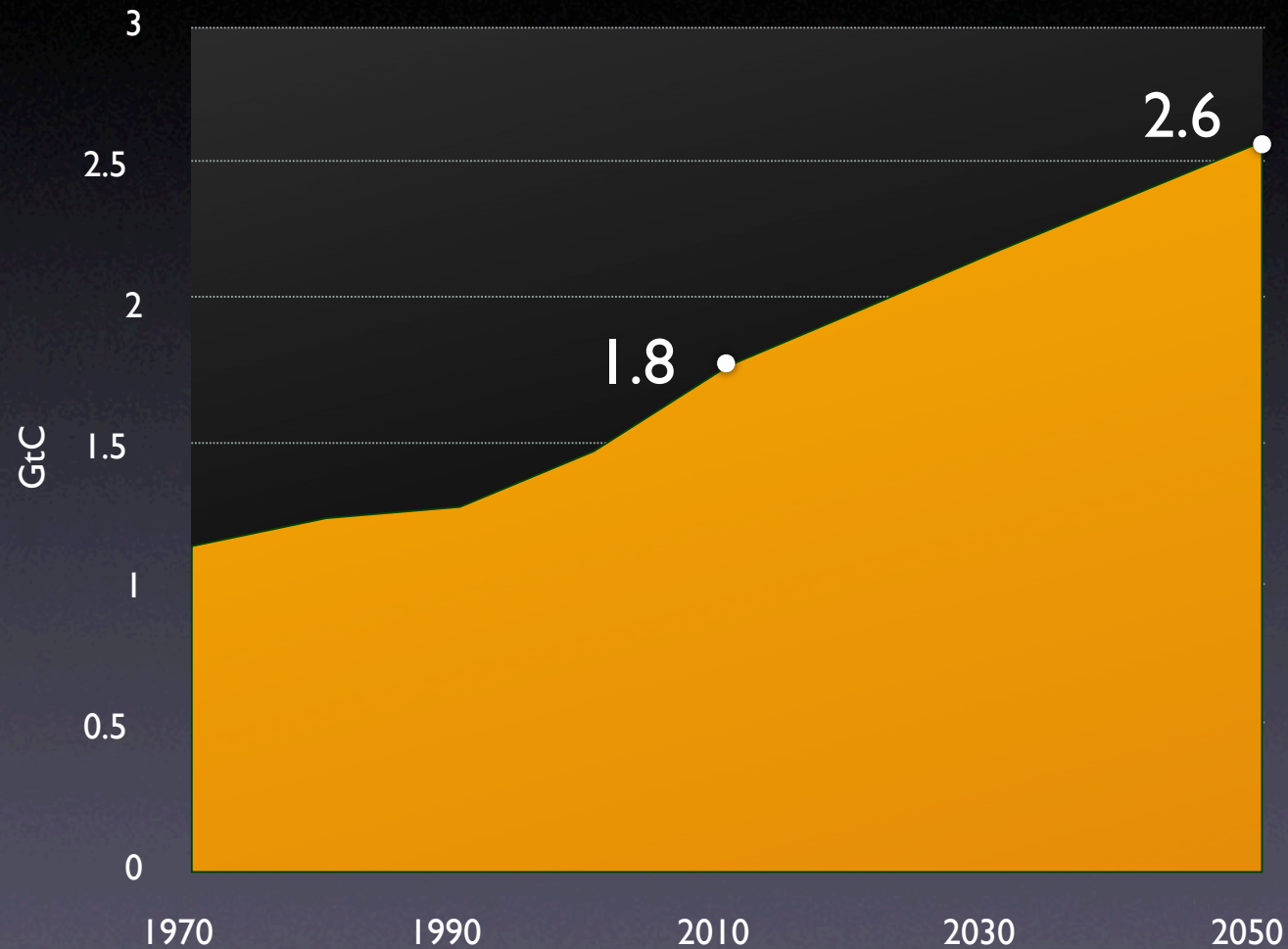
We Have the *Ability Today*



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

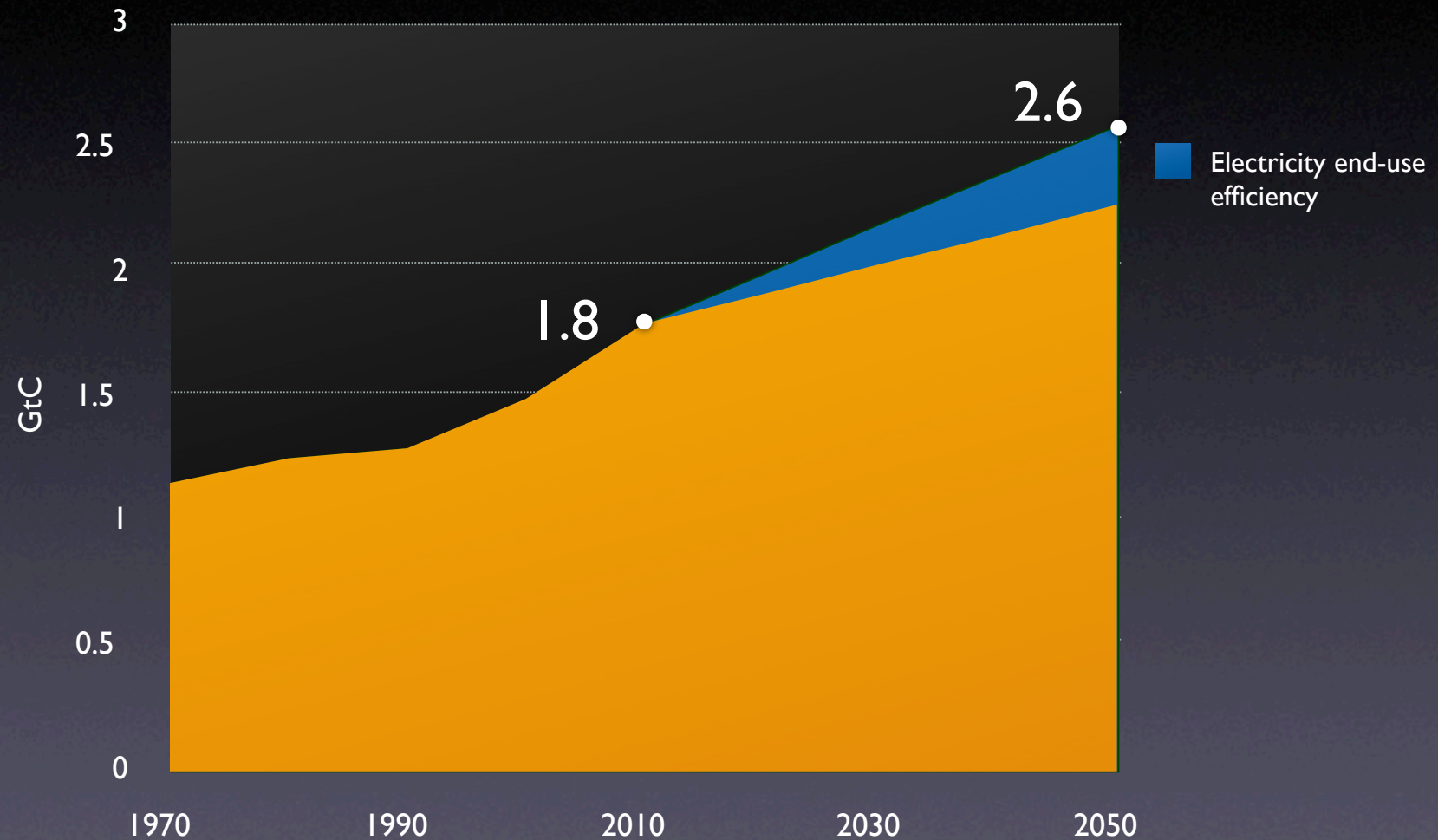
- Business as Usual



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

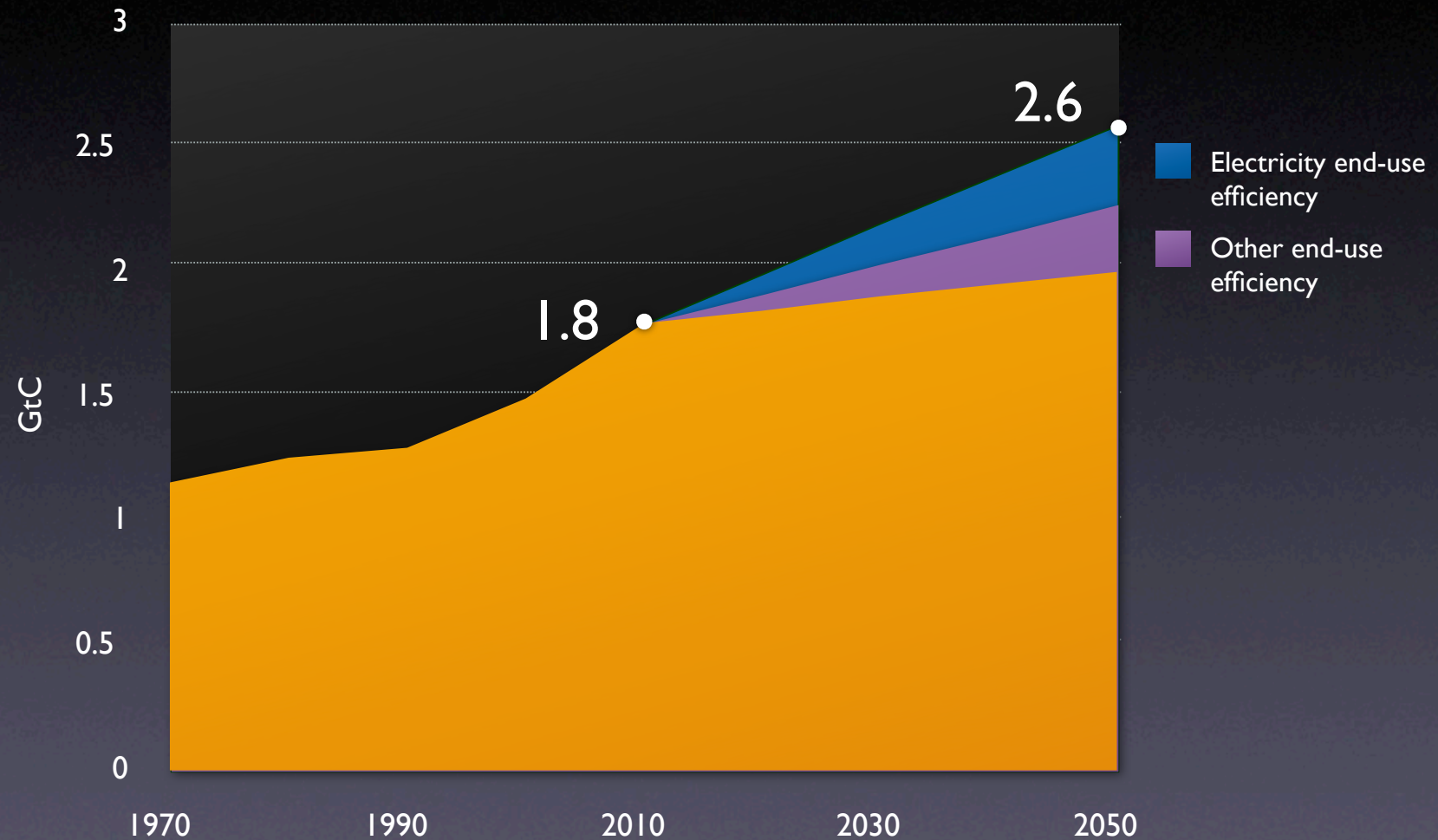
- Electrical Efficiency



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

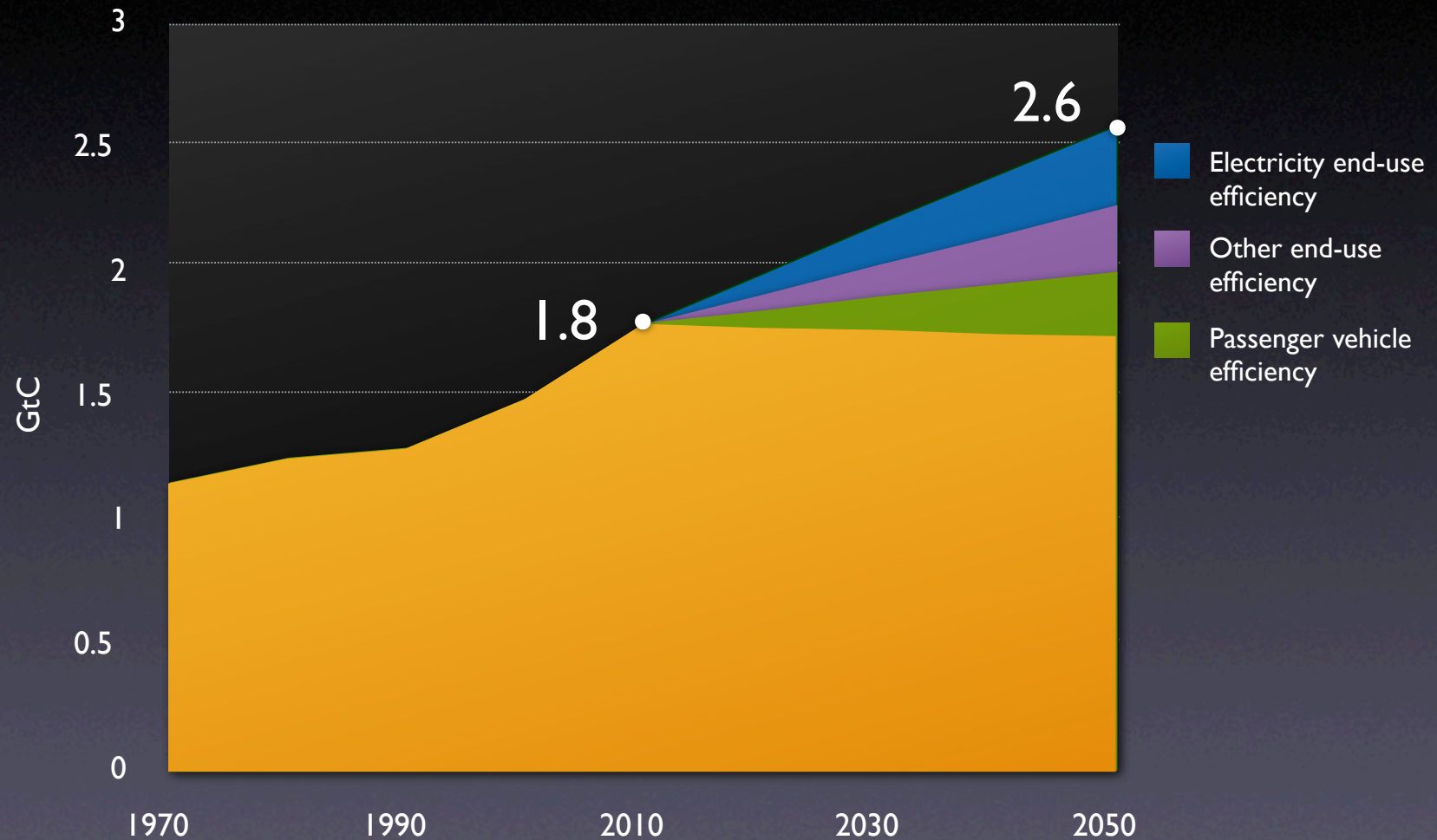
- Other End-Use Efficiency



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

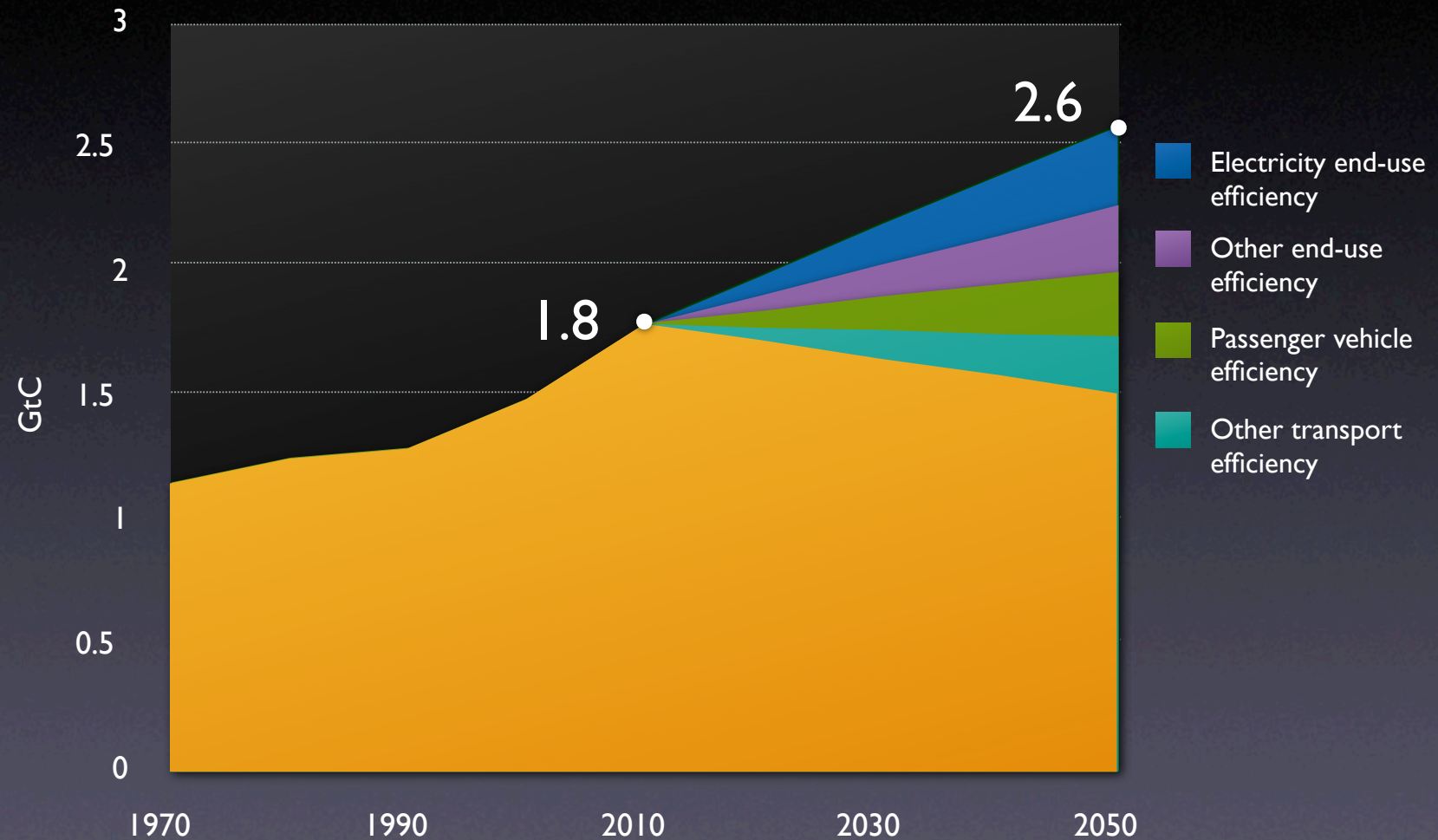
- Passenger Vehicle Efficiency



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

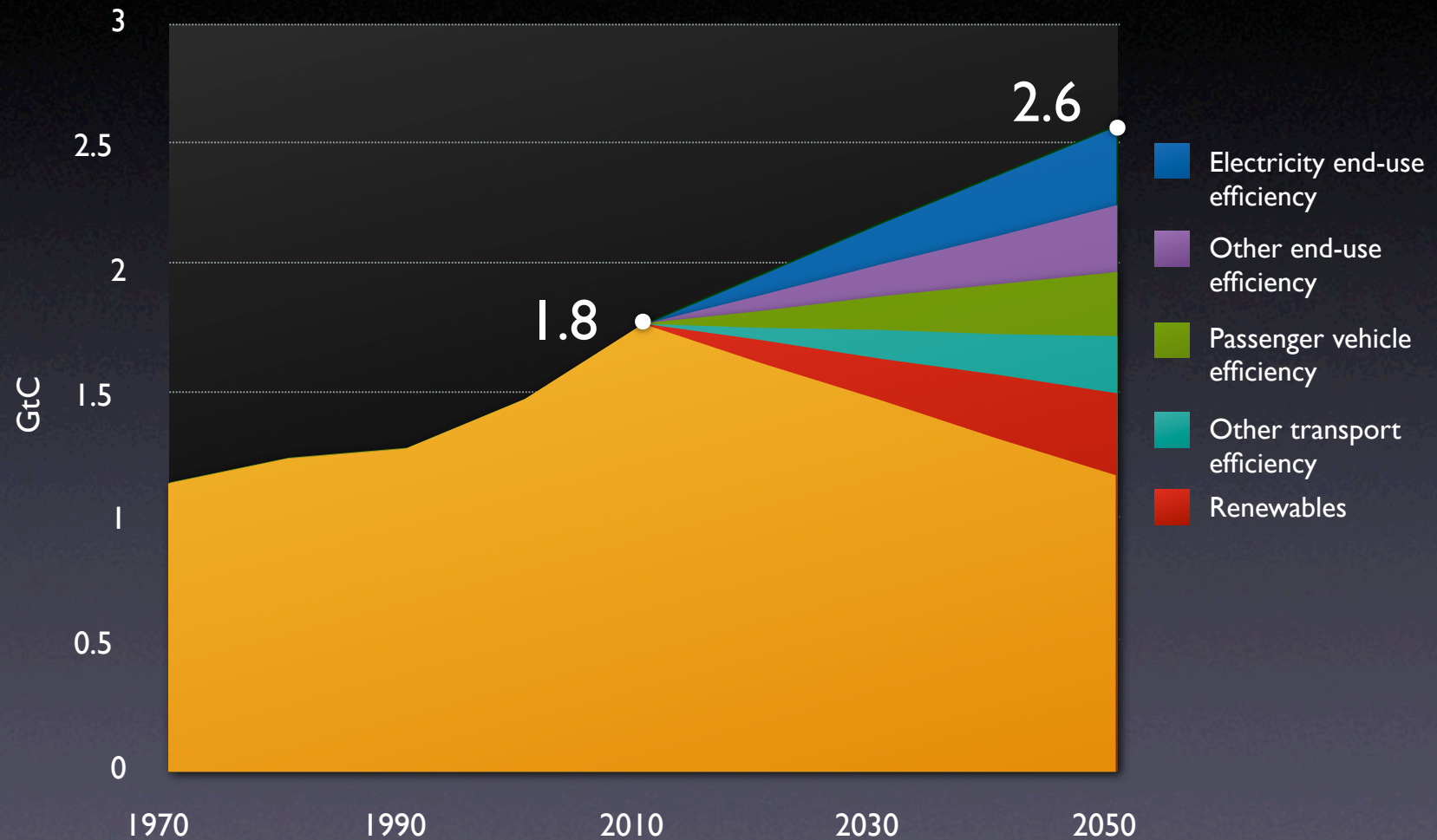
- Other Transportation Efficiency



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

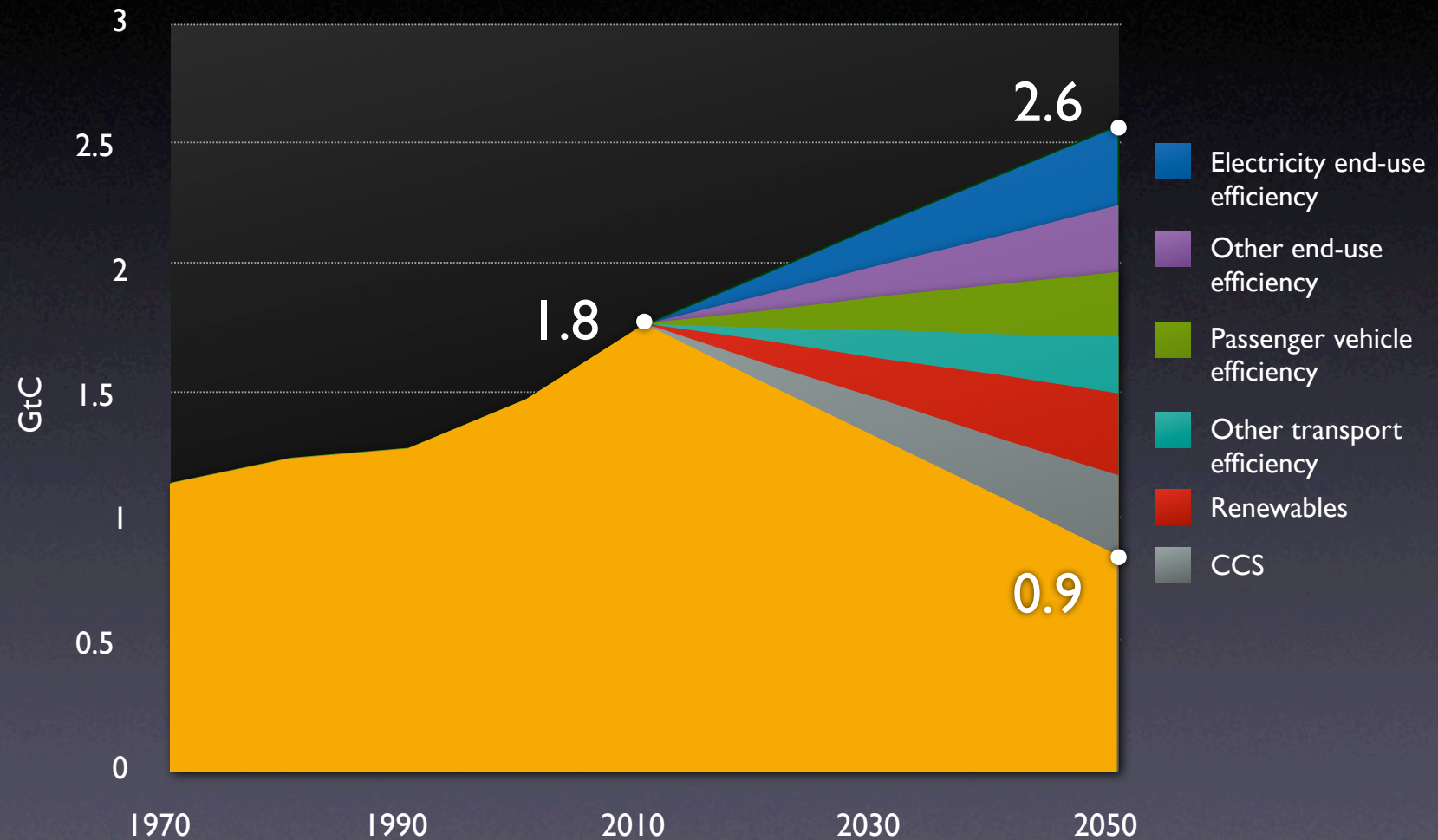
- Renewables



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

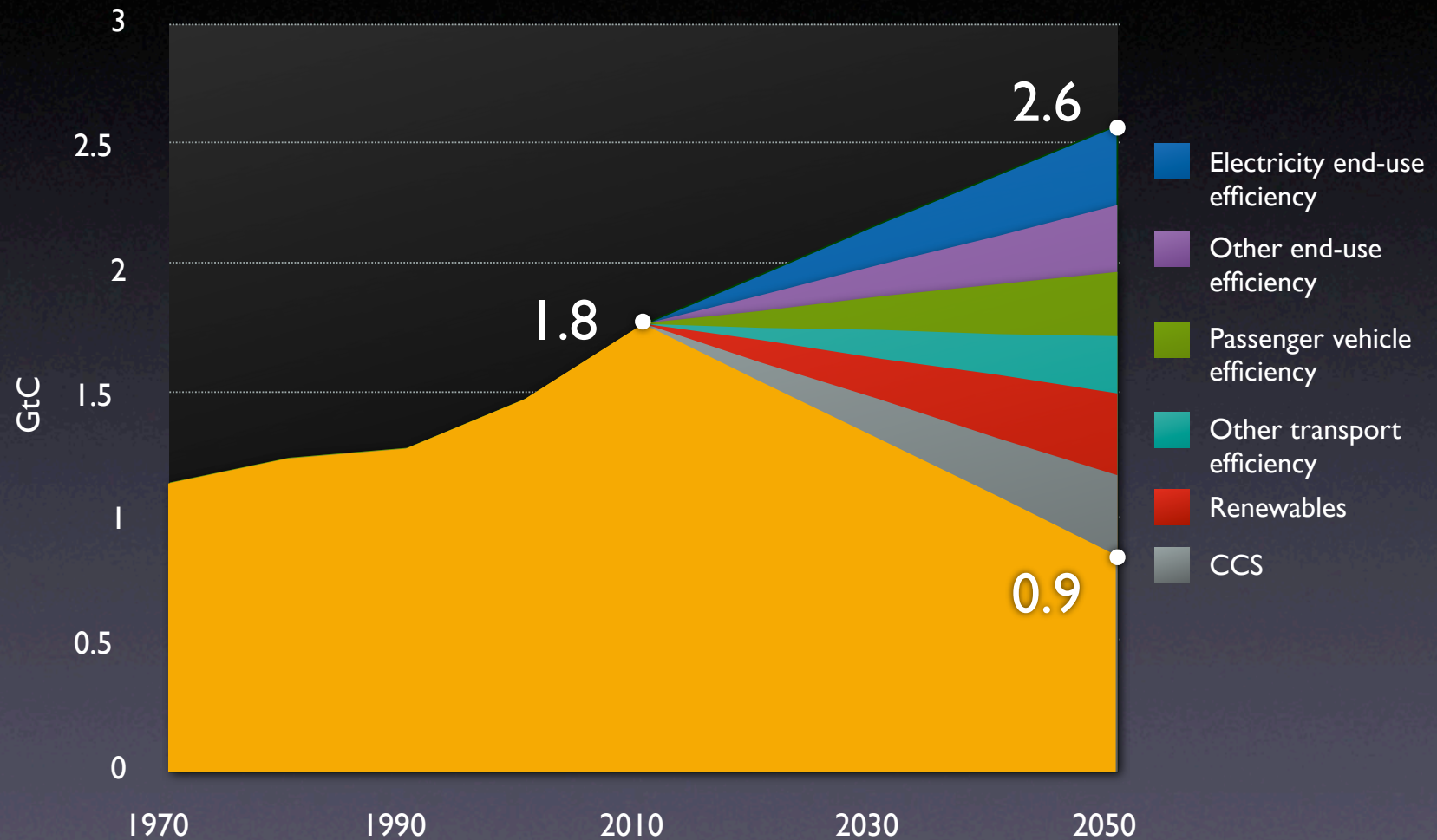
- Carbon Capture & Storage



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

- Path To U.S. Emissions Stabilization



Notice that _____ is not “THE” Solution to Climate Change

- there is no single “silver bullet”
- instead, we have “*silver buckshot*”
- many parts to the whole solution



What Can We Do in Wisconsin?



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Image: Apple

Start at Home



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Help Homes, Businesses

- goal: cut emissions by 50%
 - *transportation*
 - *electricity*
 - *heating*
- then offset remaining emissions
 - *planting trees, prairies*
 - *conserve energy elsewhere*

we didn't meet our goal
we exceeded it

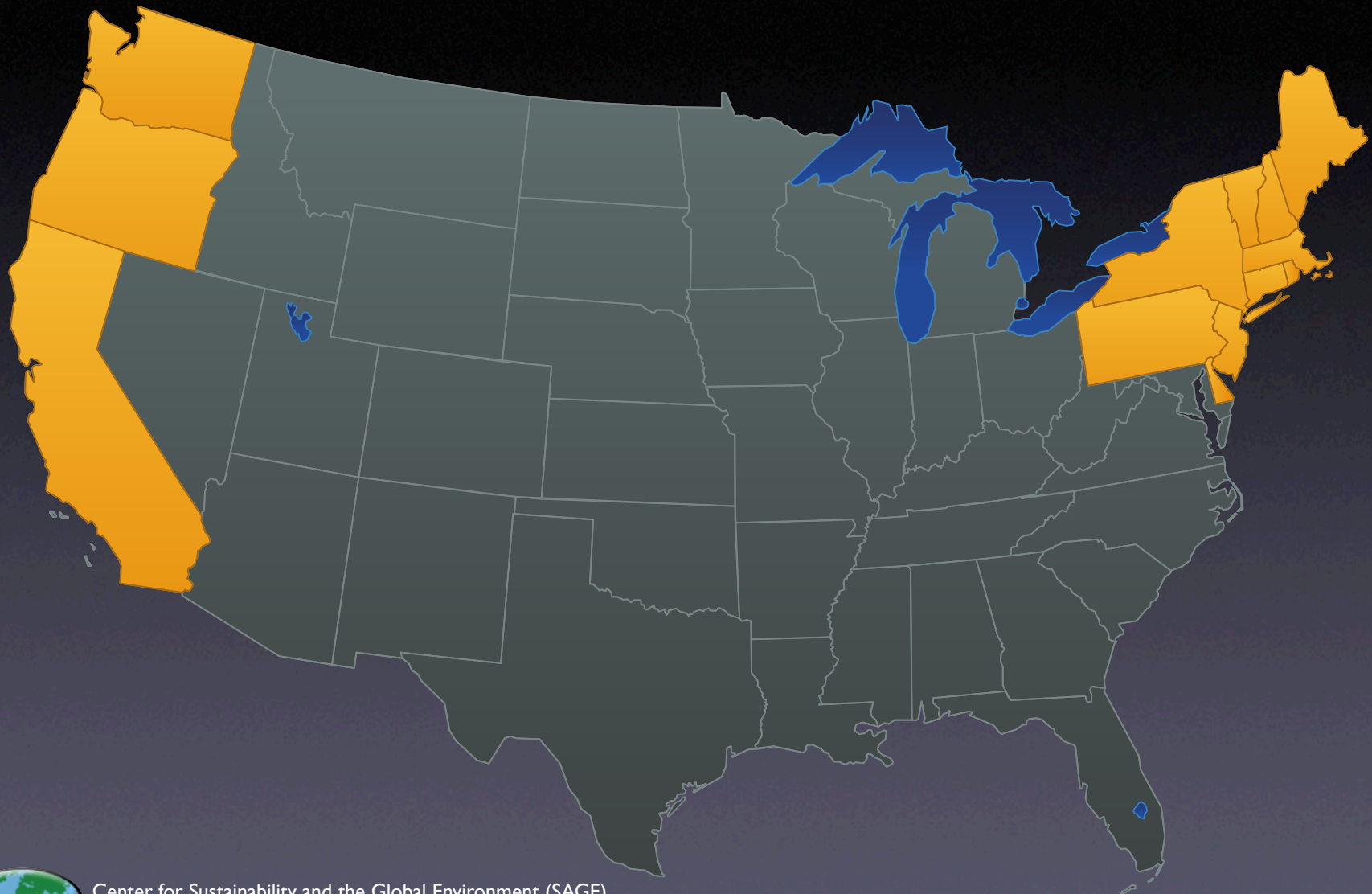


*So, how many Foley's
does it take to
change a light bulb?*

*Toyota Prius
50% less CO₂, 90% less NO_x*



Join Other State Policy Initiatives



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Be Proactive



A Challenge for Wisconsin?

- instead of just *reacting* to climate changes as they occur in Wisconsin
- how can we be proactive?
 - *need to start moving on the energy / emissions side*
 - *consider new legislative proposals, mirroring California laws*
 - *but also need to increase our ability to adapt to future climate changes*



Remember, this is a
Huge Opportunity



Whole New Energy Systems

- first generation renewables
 - *wind already cost-effective, solar getting there*
- new biological systems?
 - *ethanol, biodiesel*
 - *bioreactors*
- energy farms?
 - *Wisconsin: wind above, biofuel below?*
 - *Brazil: energy exporter by 2015?*



Take a *Long-Term* Perspective



Plan for the Future

- this will take time
- we need to get started now
- and we need to be in league with the future
 - *previous generations have done it*
 - *so can we!*



Plan for the Future

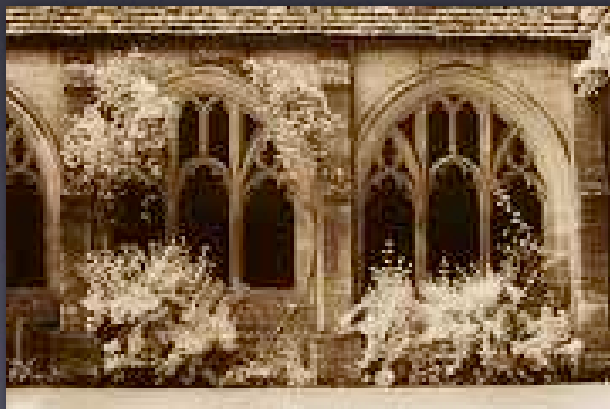


- New College, Oxford (c. 1386)

“...I think of the oak beams in the ceiling of College Hall at New College, Oxford. Last century, when the beams needed replacing, carpenters used oak trees that had been planted in 1386 when the dining hall was first built.

The 14th-century builder had planted the trees in anticipation of the time, hundreds of years in the future, when the beams would need replacing.

Did the carpenters plant new trees to replace the beams again a few hundred years from now?”



– Danny Hillis
Vice-President for Research and Design
Walt Disney Co.



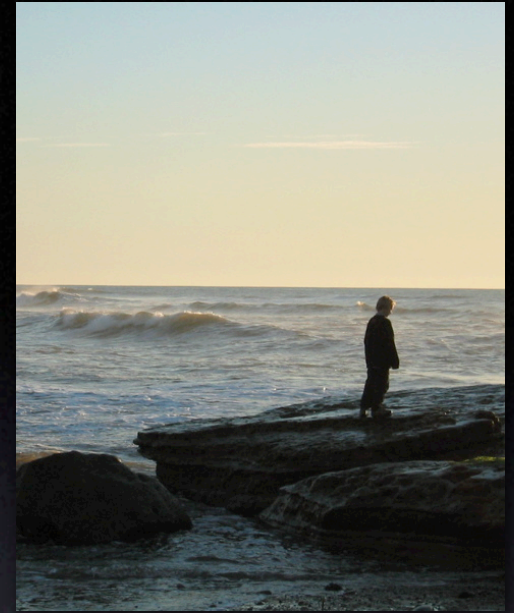
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Ultimately, This is a Moral Issue...



A Defining Moment

- what we do *now* will affect these future generations, and beyond
- we are being called upon to be the best people we can be
- this is our choice...



who we are...

...who we could be

the world that is...

...the world that should be



Thank You



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